PRELIMINARY REPORT

TO THE LONG TERM IMPACT ASSESSMENT GROUP

PROGRAM 7

IMPACT ON AND RECOVERY OF SUBTIDAL REEFS

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EFFECT OF THE IRON BARON SPILL

PROGRAM 7 - IMPACT ON AND RECOVERY OF SUBTIDAL REEFS

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EXECUTIVE SUMMARY

The impact of the *Iron Baron* oil spill on subtidal reef communities in Bass Strait was assessed by quantitatively censusing plant and animal populations after the spill and comparing these data with information obtained using similar techniques prior to the spill. Natural changes at control sites were of a similar magnitude to changes in reef assemblages following the spill at sites with moderate and heavy oil contamination on nearby shores. Any effects of the oil spill on subtidal reef assemblages were therefore considered to be minor. By contrast, the grounding of the hull at Hebe Reef caused complete destruction of plant and animal life within a localised zone extending for ≈170 m by 20 m. The fish population within this disturbed zone largely recovered to predisturbance levels within three months of the impact whereas very little recovery of invertebrate and virtually no recovery of macroalgal populations occurred during this time period.

Given the lack of significant impact of the oil spill on coastal reefs, further monitoring of reef communities is not considered necessary. Limited monitoring of the impact zone and two nearby control sites on Hebe Reef is recommended in order to identify the timescale required for assemblages in this region to recover.

OBJECTIVES

The aim of this project was to quantify any impact on subtidal reef communities resulting from the substantial quantities of fuel oil released at Hebe Reef during the grounding of the *Iron Baron*. The specific objectives of the program were to:

1. Determine the extent of damage to Hebe reef plant and animal communities caused by the grounding of the *Iron Baron*.
2. Determine the type and scale of impact of the spilled oil and the use of dispersants on subtidal rocky reef communities in northern Tasmania.
3. Identify when affected reef communities have recovered to the predisturbance state.

At the commencement of the study, the scale of the impact was unknown but probably extended across one of the following geographic areas:

(i) the impact was confined to the immediate accident site at Hebe Reef, with the effects of oil pollution minor and possibly less important than the physical damage done by the grounding of the ship's hull
(ii) oil affected subtidal reef communities at Hebe Reef and within a confined area near the mouth of the Tamar estuary where moderate and severe oiling was noticed onshore
(iii) oil affected subtidal reef communities through a large region of central Bass Strait (ie. from approximately Port Sorell to Five Mile Bluff), the region that oil deposits have been noticed onshore.

Accordingly, sampling of reef biota was carried out with the aim of planned statistical comparisons between:

(i) plant and animal populations at Hebe Reef versus populations at nearby coastal sites
(ii) populations on reefs near the mouth of the Tamar versus populations on reefs 10-30 km distant
(iii) populations on reefs from Port Sorell to Five Mile Bluff versus populations on reefs 50-100 km distant.

INTRODUCTION

The bulk carrier *Iron Baron* ran aground on Hebe Reef in northern Tasmania on 10 July 1995, rupturing fuel tanks and releasing approximately 350 tonnes of Bunker C plus small amounts of diesel fuel. Lesser quantities of the 550 tonne load of fuel oil were also released during the succeeding week, a period when the hull became increasingly damaged by wave action and salvage operations were undertaken. An additional discharge of 20-25 tonnes occurred when the boat was towed off the reef on 16 July. Much of the released fuel rapidly washed ashore onto the nearby coast, fouling beaches and rocky shores at the higher tidal levels.

Oil that became stranded on the shoreline had an obviously detrimental effect on intertidal plants and animals, with high mortalities occurring in localised areas. The

impacts of oil on subtidal marine life were, however, much more difficult to categorise because they could not be directly observed. Public concern was expressed at the time about the effects of oil on the species-rich reef communities in the Bass Strait region, and, in particular ,the impact of the spill on fishery resources such as abalone. Unfortunately, investigations on impacts of oil spills elsewhere in the world provided little assistance at predicting the fate of local reef communities; very few previous studies of the impact of oil on rocky reef assemblages have been reported.

Given the unknown but possibly considerable effects of the *Iron Baron* spill on subtidal reef-associated plants and animals, a need existed to quantify the impact of oil on this biota and to determine at what stage reef communities had returned to their pre-disturbance state. Fortuitously, quantitative information on the densities of fishes, large invertebrates and macroalgae had been collected from a number of reefs in the region during the preceding three year period. These data, plus additional data obtained using similar methods after the spill, allow the most rigorous statistical analysis of the effects of an oil spill on subtidal reef biota that has yet been undertaken.

RELEVANT PREVIOUS STUDIES ON EFFECTS OF OIL ON MARINE LIFE - INCLUDING EFFECTS ON SUBTIDAL REEF COMMUNITIES

Slicks generated during oil spills dissipate and are altered as a result of a number of chemical and biological processes that are collectively known as weathering (Gerlach, 1981). During the first day, oil slicks rapidly spread by thinning until a fine layer of oil covers large areas of the sea surface. Most chemicals with high toxicity that are present in the oil, such as benzene, xylene and toluene, evaporate at this time.

Wave turbulence disperses large quantities of oil as small droplets suspended in water, while a minor proportion of the oil dissolves. If wave action is severe, droplets of water sometimes froth the oil, producing a buoyant "mousse". Oils emulsified into a mousse are generally found to decompose at a much slower rate than non-emulsified oils, so travel longer distances and are more hazardous to marine life when washed ashore.

The *Iron Baron* grounded during a period of high wave turbulence, so benthic plants and animals at moderate depths (to at least 15 m at Hebe Reef) probably came into contact with dispersed droplets and larger blobs of oil. Contact with reef organisms at depth was probably facilitated by the high specific gravity (=0.978) of the Bunker C fuel released during the spill. Small quantities of oil washed ashore near West Head were found to have emulsified.

After the first day, weathering processes are primarily controlled by exposure to sunlight (photooxidation), sorbtion onto sediment particles and microbial degradation. The rate at which oil is degraded by bacteria, fungi and protozoans differs greatly between spills, depending primarily on water temperature, oxygen and the natural abundance of oil-degrading micro-organisms. A lack of nutrients can also limit microbial degradation of oil residues, as was found after the *Exxon Valdez* spill in Alaska where the application of fertiliser resulted in the quicker recovery of degraded shores (H. Kirkman, pers. comm.).

The usual end product of crude oil and Bunker C weathering is inert tar balls, which drift on the ocean surface and wash ashore or sink to the seabed.

The effects of oil spills on plants and animals depend partly on the degree of weathering because different petroleum compounds possess vastly different properties and toxicity. Many of the lighter petroleum products such as petrol are highly toxic but evaporate rapidly, while heavy lubricating oils and tars have lower toxicity but can persist in the marine environment for many years. The polycyclic aromatic hydrocarbons (PAHs) are unusually toxic and persistent in the environment. They are accumulated within the tissues of filter-feeding invertebrates and are believed to cause cancers amongst humans and disease amongst some marine organisms (Grimmer, 1983). Any long term impacts of the PAHs have not been investigated here but are probably slight given the level of dilution of the released oil and the minute levels present in the environment that are attributable to the *Iron Baron* spill.

Previous studies indicate that the impact of oil spills on plant and animal communities can rarely be accurately predicted because of interactions between several important factors: (i) the degree of weathering and chemical composition of the oil, (ii) the quantity and patchiness of the oil, (iii) the persistence of the oil, and (iv) whether the community is naturally adapted to high levels of oiling. Predictions are further complicated by large differences between species in their vulnerability to oil (Chassé, 1978).

Ecosystems that are naturally subjected to high levels of oil, sewage or other organic loadings generally exhibit a high biological tolerance to oil spills (Berge, 1990). Nearly all communities in the Persian Gulf affected by the massive oil spillage during the Gulf War, for example, rebounded rapidly to pre-disturbance conditions (Literathy, 1993). Bass Strait ecosystems are oligotrophic and adapted for very low natural nutrient levels, so probably have a relatively low resistance to the effects of oil.

Because petroleum compounds are less dense than water, the biota associated with high intertidal sandflats, mudflats, mangroves and saltmarshes can be greatly affected by relatively slight spills. Shallow subtidal assemblages can also be severely impacted by oil. For example, following the large *Amoca Cadiz* spill most local species of amphipod were eliminated from subtidal sediments; some of the more abundant of these species had not recolonised ten years later (Dauvin and Gentil, 1990). Oil is also likely to have a substantial effect on sea-surface plankton; however, these communities remain very poorly studied (see Conover, 1971). In one North American investigation damage was detected amongst all eggs of several fish species following a 2,600,000 litre petrol spill (Griswold, 1982).

A number of experiments have been conducted to determine the impact of oil on intertidal plants and animals in Australia. Stranded oil kills mangrove seedlings (*Avicennia marina*) and saltmarsh plants (*Sarcocornia quinqueflora* and *Sporobolus virginicus*) at relatively low concentrations. Recolonisation of vegetation is generally slow because of oil residues that persist in the sediment (Grant et al., 1993; Clarke and

Ward, 1994). Mudflat mollusc and crustacean populations also show high vulnerability to oil spills. Populations of these organisms nevertheless recovered in experiments within a few months to predisturbance levels because of rapid immigration from non-oiled patches of mudflat (McGuinness, 1990). Much slower rates of immigration would be expected when habitats are impacted by large oil spills that destroy most of the local community. Population recovery in these situations requires larvae to settle from the plankton.

The initial impact of oil can be as severe on rocky intertidal habitats as on intertidal sand and mud flats, with loss of the majority of species in extreme situations; however, oil is rapidly washed from rocky shores whereas it may remain embedded and continue to leach from soft sediments for many years (Gerlach, 1981). Most rocky shore communities therefore appear to recover much more rapidly than communities on mudflats. In some of the most severe spills (>1,000 tonnes), intertidal rocky shore communities nevertheless require a number of years to return to predisturbance states (Garrity and Levings, 1990).

The effects of oil on subtidal coral reef communities have been studied at a number of locations, including investigations of chronic releases of petroleum products as well as pulse spills (reviews by Johannes, 1975; Loya and Rinkevich, 1980; also Bak, 1987; Jackson et al., 1989; Guzman et al., 1991; Guzman and Holst, 1993). Substantial local reduction in coral diversity and changes to community structure have been detected in most cases, although impacts on Persian Gulf reef communities following the massive Gulf War spillages were apparently slight (Downing and Roberts, 1993).

In contrast to the many studies of impacts on coral reefs and subtidal soft sediment habitats (reviewed in Teal and Howarth, 1984), the effects of oil on subtidal rocky reef communities are very poorly researched. Nothing has been reported in the primary literature on the effects of oil on subtidal reef-associated invertebrates and fishes, although these effects may be large given that substantial quantities of dead fishes have been washed onto beaches after some spills and substantial mortality of invertebrates occurs on rocky intertidal shores (Hampson and Sanders, 1969; Chassé, 1978; Maurin, 1981; Teal and Howarth, 1984). Grazing molluscs and crustaceans appear to be particularly susceptible to oil whereas suspension-feeders as a group are relatively resilient (Chassé, 1978).

The effects of oil on macroalgal species have been reviewed by O'Brien and Dixon (1976), although virtually all studies reported by them involved intertidal habitats. Subtidal macroalgae do not generally die or exhibit reduced growth rates following oil spills (Peckol et al. 1990), except in the most severe situations (Jackson et al, 1989). For one macroalgal species in the Arctic (*Dictyosiphon foeniculaceus*), an increase in growth rates was detected during the year following experimental releases of oil, possibly because of the slow release of nutrients associated with oil in sediments (Cross et al, 1987). Macroalgal species thus appear to possess a relatively high resistance to oil spills, as is seen on northern Hemisphere rocky shores when the alga *Fucus* survives but most animals are lost following spills (Notini, 1980). In general, the sensitivity of

macroalgae on shores declines from high to low intertidal levels, with filamentous red algae the most susceptible to spills (O'Brien and Dixon, 1976). Virtually all macroalgae, particularly rhodophyte species, are much more susceptible to dispersants than to oil. BP 1002, the detergent used following the *Torrey Canyon* spill, for example, was lethal to the subtidal alga *Delesseria sanguinea* at dilutions as low as 10 p.p.m. (Smith, 1968).

METHODS

Fishes, invertebrates and macroalgae were quantitatively censused at 5 m depth at a number of sites in northern Tasmania during the three year period prior to the *Iron Baron* oil spill and again shortly after the spill. A number of sites were censused on two occasions after the spill, firstly during August 1995 to determine acute effects of the spill and secondly during October 1995 to identify longer term effects. The dates and sites investigated are listed in the appendix, and the distribution of sites is shown in Fig. 1. Two sites without prespill information were censused at 5 m depth close to the impact zone at Hebe Reef during August 1995, while additional censuses along the centre of the impact scar made by the grounding of the hull (a region that extended from 6 to 12 m depth) were made on 10 August and 22 October 1995.

At each reef site examined, the abundance of large fishes, the abundance of cryptic fishes and benthic invertebrates, and the percentage cover of macroalgae were each censused separately using visual transect methods. The densities of large fishes were estimated by laying four 50 m transect lines along the 5m depth contour and recording on waterproof paper the number of fish observed by a diver while swimming along the centre of a 5m wide swathe up one side and then down the other side of the line. A total of 4 x 500 m^2 transects was thus censused for large fish at each site.

Smaller fishes and megafaunal invertebrates (large molluscs, echinoderms, crustaceans) were counted along the transect lines used for the fish survey by recording animals within 1 m of one side of the line (a total of 4 x 50 m^2 transects). The distance of 1 m was assessed using a measuring stick carried by the diver. The percentage cover of macroalgal species was then determined by placing 0.5 m x 0.5 m quadrats at 10 m intervals along the transect line and estimating the percentage cover of the various plant species. Each replicate used in analyses involving plant data included the mean cover of the five quadrats within each 50 m length of survey line.

Due to time constraints, invertebrates and macroalgae were not censused at two sites in the Waterhouse region (Waterhouse Point and north Waterhouse Island) and invertebrates were not censused at Five Mile Bluff during the initial prespill surveys.

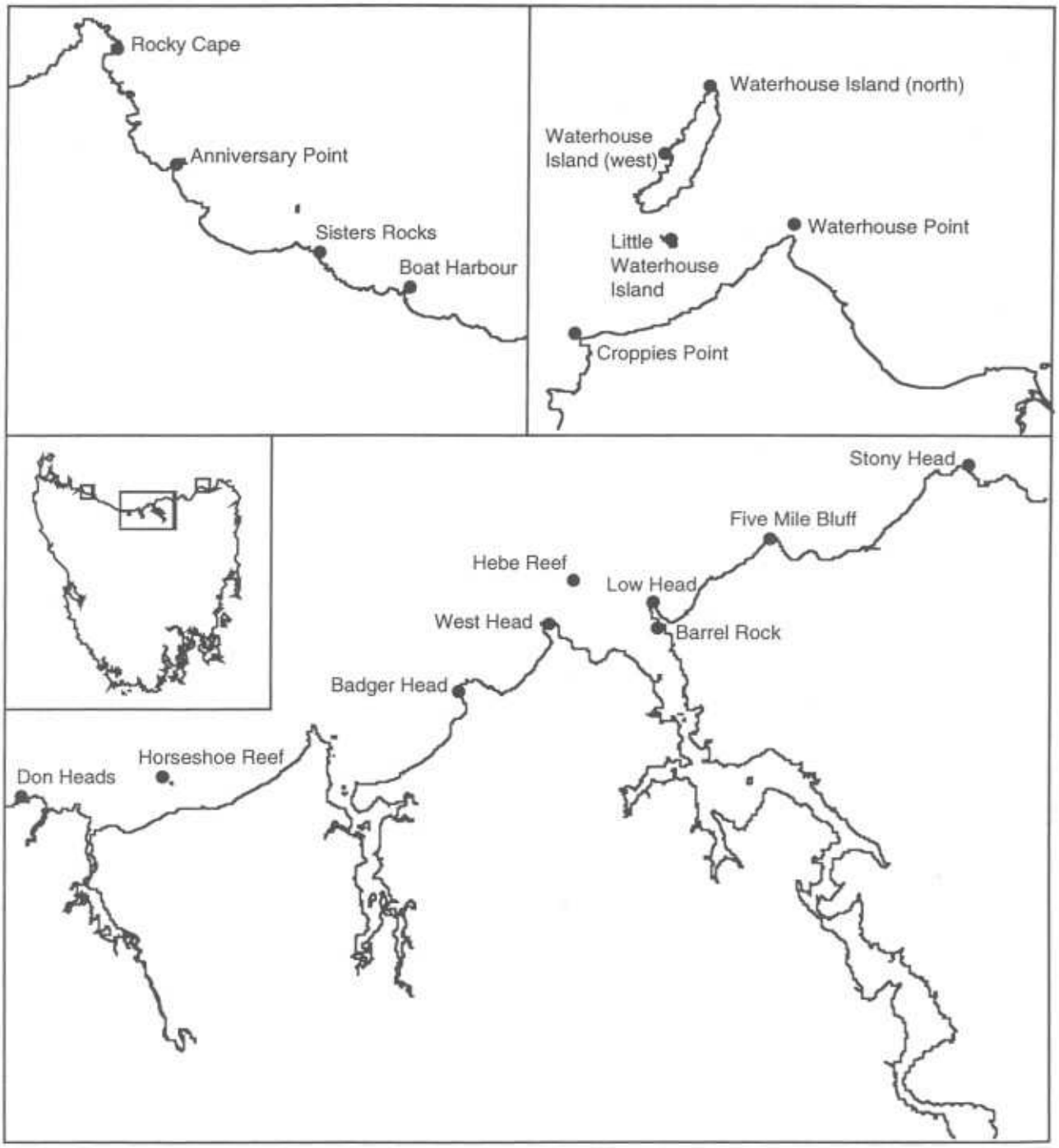

Fig. 1. Map showing the location of reef sites cenusused during the study

Statistical analyses

Data were initially analysed using the ordination procedure multidimensional scaling (MDS) to identify relationships between plant and animal assemblages at different sites and to determine whether these patterns changed in a consistent pattern following the spill. Two data matrices were analysed in this way, the first containing data describing the mean density of organisms at each site (log x+1 transformed) and the second with this information reduced to presence/absence form. These matrices were converted to symmetric matrices of biotic similarity between pairs of sites using the Bray-Curtis similarity index. The similarity matrices were agglomeratively clustered using ranked data and group-averaging, as suggested by Clarke (1993), and presented using MDS as the best graphical depiction in two dimensions of the biotic similarities between sites. The usefulness of this two dimensional display of relationships between sites is indicated by the stress statistic, which is <0.1 if the depiction of relationships is good, and >0.2 if the depiction is poor (Clarke, 1993).

Univariate analyses of the data were made using Analysis of Variance (ANOVA) to determine whether the abundances of individual species or total number of species changed following the oil spill. These analyses were confined to the most abundant species because many zeros were present in the data set for less common species, compromising the normality and heteroscedasticity assumptions of the ANOVA. Box plots were used to determine which species violated these assumptions. Data were generally log (x+1) transformed for individual species and remained untransformed when species richness was examined.

Visual estimates of the quantities of oil washed ashore made by shoreline clean-up teams (SCAT) indicated that shores adjacent to two reefs investigated on the Tasmanian coast, Barrel Rock and West Head, were heavily oiled, while an additional site nearby, Low Head, was moderately oiled. Light oiling of shores occurred over a wider area of the coast, extending from the vicinity of Port Sorrell to Five Mile Bluff. Dispersant (BPAB) was applied near the Hebe Reef, Low Head and Barrel Rock sites, with the largest quantities (≈600 l of BPAB concentrate) used to clean shores at Low Head.

Because of uncertainty about the scale of impact of the spill (i.e. whether this was negligible, localised near the impact site at Hebe Reef, localised in the area where oil came ashore in large quantities around the entrance to the Tamar estuary, or extended throughout the central north coast of Tasmania within the region some oil washed onto beaches), analyses of data were conducted using ANOVA with planned statistical comparisons at three scales. The specific null hypotheses tested were:

(i) No significant differences were present between biota associated with Hebe Reef and biota at nearby mainland sites following the spill.
(ii) No significant changes occurred before and after the spill between biota associated with reefs at the mouth of the Tamar (West Head, Barrel Rock, Low Head) and biota at reefs 10-30 km distant.
(iii) No significant changes occurred before and after the spill between biota associated with reefs from Port Sorell to Five Mile Bluff and biota at reefs further afield (including the Rocky Cape and Waterhouse regions).

In these ANOVAs, site was considered a random factor nested within region. Time (before or after the spill) and region (putatively impacted or unimpacted) were considered fixed factors. Time data were not available prior to the spill from Hebe Reef, hence time could not be incorporated into the test for null hypothesis (ii).

RESULTS AND DISCUSSION

Description of subtidal reef near the impact zone

Hebe Reef comprises a structurally-heterogeneous doleritic reef complex with numerous bommies rising 1-3 m from the seabed. On grounding, the hull of the *Iron Baron* physically abraded the substratum, shaving the tops off the higher reef projections and depositing crushed rock in the form of gravel within crevices and gutters. The major impact zone extended for a distance of ≈170 m from 6 m to 12 m depth and has an average width of ≈20 m. All large marine life was destroyed within this region at the time of the impact. A few large steel plates remain on the seabed within the impact zone.

When examined on 9 August 1995 (30 days post spill), no foliose macroalgae or large invertebrates were seen within the region of physical impact. A filamentous *Ectocarpus*-like brown alga coated the reef substratum. At the ends and along the sides of the hull scar, reef plants and animals occurred interspersed amongst open *?Ectocarpus*--covered rock, with numerous fishes swimming out from these areas across the hull scar. No obvious oil-induced effects, such as dead or senescent algal fronds were noticed. Rather than a gradient of loss of species out from the site of the grounding, adjacent reef patches superficially appeared to have either lost the complete biotic assemblage or be relatively intact.

Quantitative reef transects were conducted on 8 and 9 August 1995 along the 5 m depth contour at sites that commenced ≈50 distant to the southwest and southeast (≈150 m northeast and northwest of the Hebe Reef marker light). Given the prevailing winds and rough sea state, the reef in the area of these transects was considered to have experienced prolonged contact with oil as it was released from the damaged hull. No obvious effects of this oil on the biota were noticed by divers at the time of censuses.

The region of immediate impact was recensused on 22 October 1995 (i.e. 104 days post spill). No large invertebrates had recolonised the impacted area, other than a few sea urchins (*Heliocidaris erythrogramma*) at a mean density of 0.05 m^{-2}. A number of opportunistic algal species (*Petalonia fascia*, *Scytosiphon lomentaria*, *Asparagopsis* sp. and others) had settled on the bare rock within the site; however, foliose macroalgae were rare. The only large algal species to have colonised the site that was a dominant member in undisturbed areas nearby was the kelp *Ecklonia radiata*. A few 50 mm high *Ecklonia* sporelings were visible at a density of ≈0.5 m^{-2} scattered across the substratum. Fishes, particularly the planktivorous species *Caesioperca rasor* and *Trachinops caudimaculatus*, were moderately abundant above the impacted zone.

Multidimensional scaling

Reef data were initially analysed by MDS to provide the best spatial representation in two dimensions of the biotic relationships between sites and to show changes at individual sites over time (Figs 2, 3 and 4). Mean abundance of invertebrates and fishes and percent cover of

macroalgae as estimated during transects were used in these analyses. These data are shown in the appendix.

The stress statistics associated with the MDS plots are all relatively high (0.17 to 0.23), indicating that the two-dimensional displays of biotic relationships are poor. Sites do not separate strongly into different groups other than for the Hebe Reef impact site, indicating that sites were located along clines in environmental conditions without major disjunctions.

The Hebe Reef impact site possessed quite different assemblages of invertebrates and macroalgae compared to other sites (Figs 3 and 4) while the fish assemblage was not greatly different to elsewhere (Fig 2). Because ≈15% of the total distance censused during transects in the impact zone at Hebe Reef extended past the zone of hull damage into relatively intact habitats, these plots substantially undervalue the magnitude of the biological effects of the hull damage. Invertebrate assemblage partially recovered within 104 days of the spill, as indicated by the movement of the impact data point toward other sites (Fig. 3). This was most evident when present/absent data were analysed because the number of recolonising individuals was low. Macroalgal assemblages, on the other hand, showed little recovery during this time period (Fig. 4), largely because of the arrival of opportunistic algae that were rare inhabitants of undisturbed reef habitat.

The two sites censused 50 m to 250 m distant from the impact zone at Hebe Reef (HB2 and HB2) possessed assemblages of fishes, invertebrates and macroalgae that grouped with those found on Tasmanian coastal reefs. The MDS therefore provided no indication that the oil spill had substantially altered Hebe Reef assemblages other than in the immediate contact zone.

Similarly, no substantial biotic shift occurred over time that was localised at the three coastal sites severely or moderately impacted by the spill (WH, LH and BR in Fig. 2). In general, community level changes at these sites following the spill were of similar magnitude to normal interannual variability at distant control sites. An exception to this pattern was the fish assemblages at the severely and moderately oiled sites because fishes at these sites differed substantially after the spill compared to those found in the 1994 surveys. However, the apparent loss of individuals and species that was responsible for these changes (see Figs 6 and 9 and appendix) probably resulted from reduced underwater visibility on those sampling dates rather than from the effects of oiling. Surveys were conducted by necessity during a period of high turbidity immediately after the spill in July, a period that would not normally be used for collecting transect data because of the low visibility (≤6 m). A highly significant relationship ($r=0.44$; $n=50$, $p<0.001$) was found at sites investigated during the study between underwater visibility (as estimated along the transect line) and number of fish species sighted during transects (Fig. 5). By comparison, the corresponding relationships between underwater visibility and number of macroalgal species ($r=0.26$; $n=50$, $0.01<p<0.05$) and invertebrate species ($r=0.07$; $n=50$, $0.05<p$) were much less significant or not significant.

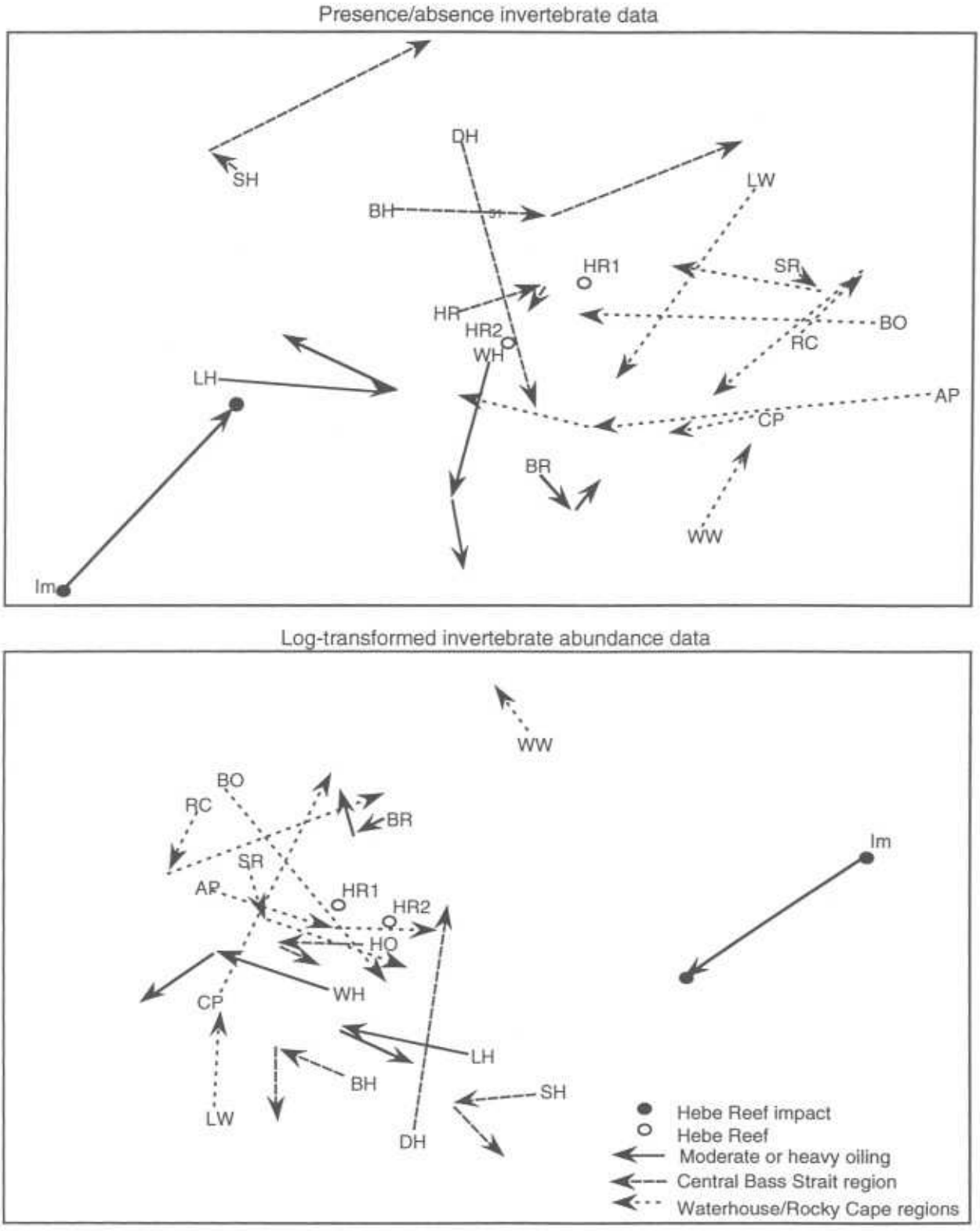

Fig. 2. Results of MDS using log-transformed abundance and presence/absence data for reef invertebrates. Site codes are as follows: Im - Hebe Reef impact site; HB1 - Hebe Reef northwest; HB2 - Hebe Reef northeast; LH - Low Head; WH - West Head; BR - Barrel Rock; BH - Badger Head; SH - Stony Head; HO - Horseshoe Reef; DH - Don Heads; AP - Anniversary Point; SR - Sisters Rocks; BO - Boat Harbour; RC - Rocky Cape; WW - Waterhouse I. west; LW - Little Waterhouse I.; CP - North Croppies Pt; WP - Waterhouse Pt; NW - Waterhouse I. north.

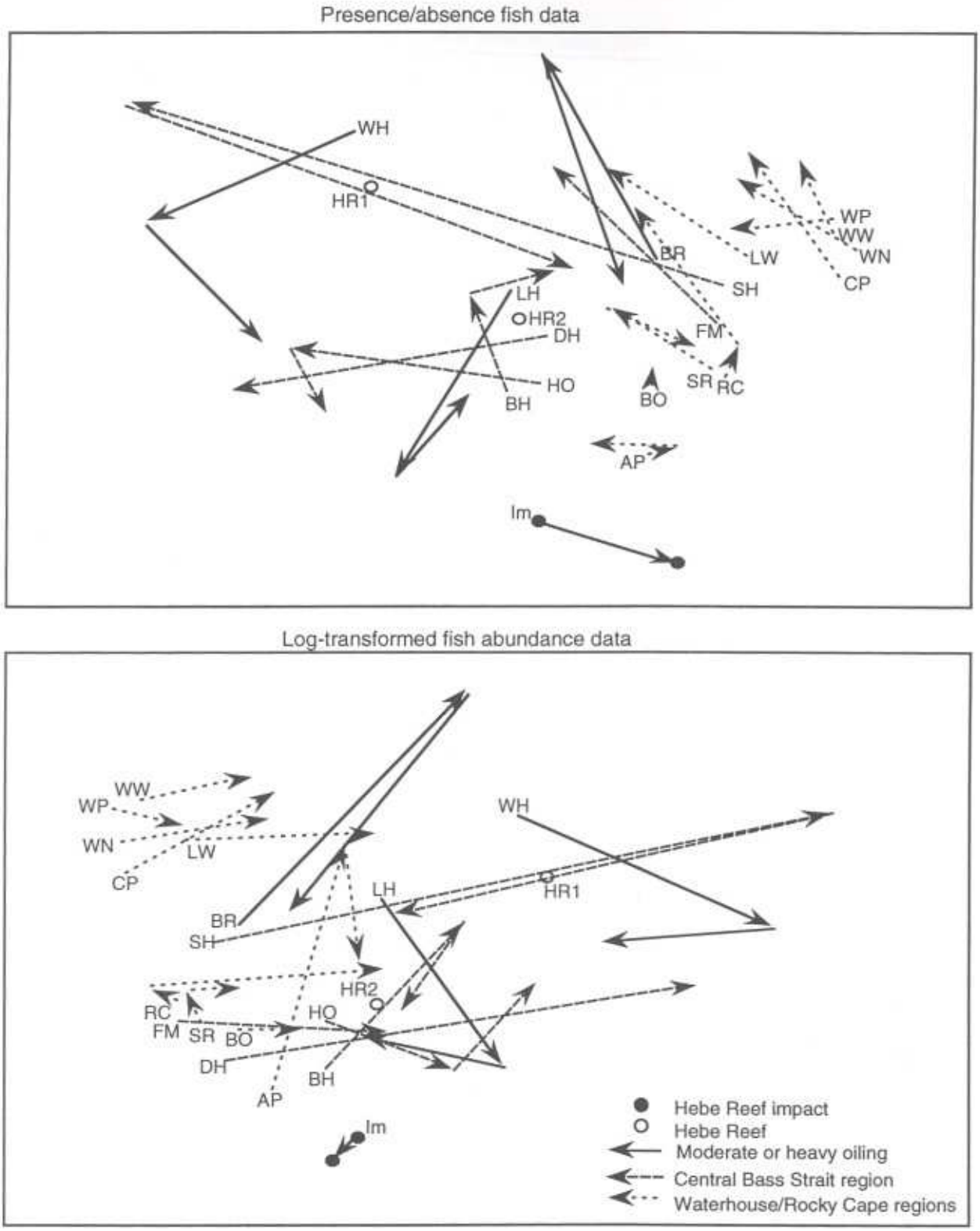

Fig. 3. Results of MDS using log-transformed abundance and presence/absence data for reef fishes. Site codes are as follows: Im - Hebe Reef impact site; HB1 - Hebe Reef northwest; HB2 - Hebe Reef northeast; LH - Low Head; WH - West Head; BR - Barrel Rock; BH - Badger Head; SH - Stony Head; HO - Horseshoe Reef; DH - Don Heads; AP - Anniversary Point; SR - Sisters Rocks; BO - Boat Harbour; RC - Rocky Cape; WW - Waterhouse I. west; LW - Little Waterhouse I.; CP - North Croppies Pt; WP - Waterhouse Pt; NW - Waterhouse I. north.

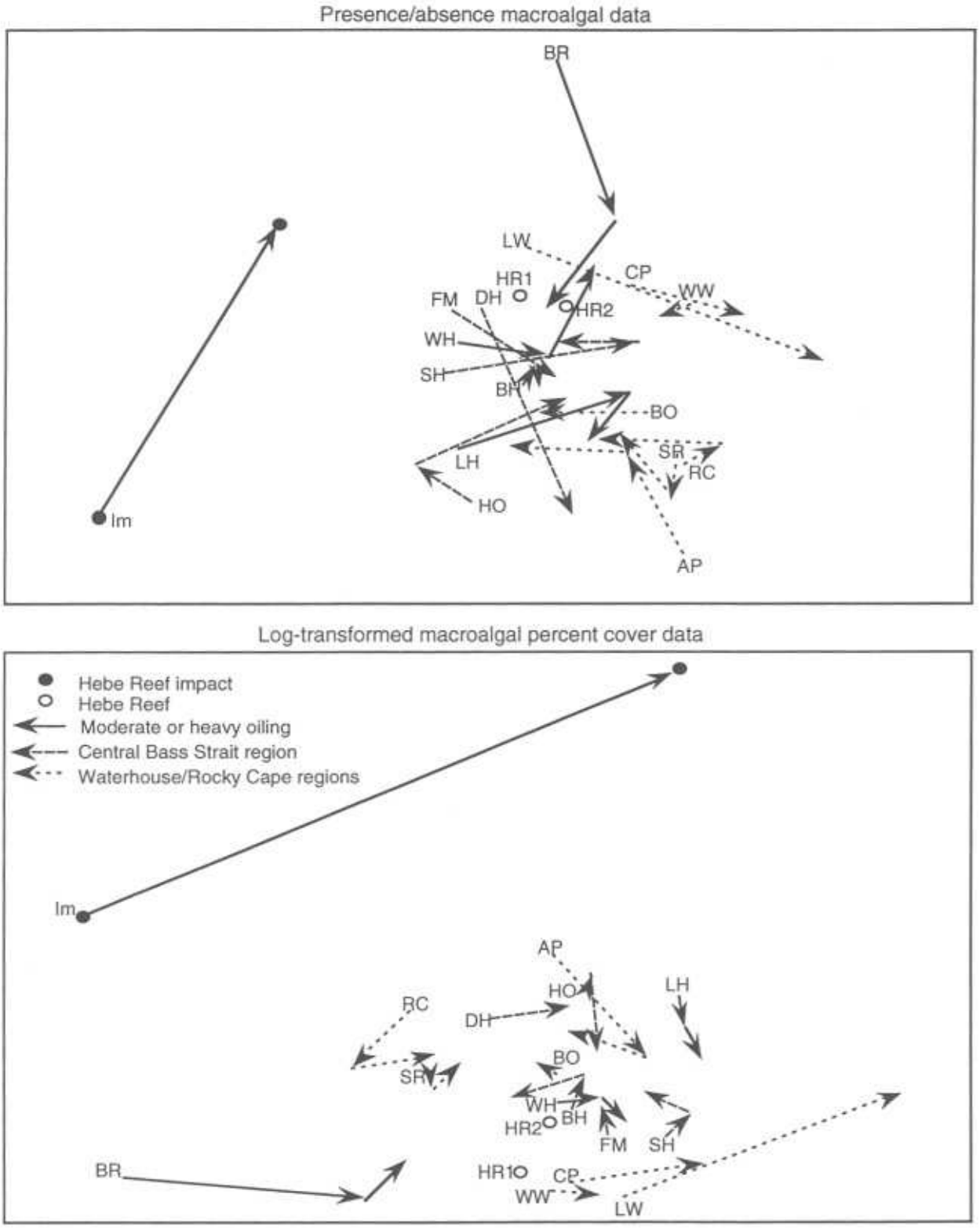

Fig. 4. Results of MDS using log-transformed cover and presence/absence data for reef fishes. Site codes are as follows: Im - Hebe Reef impact site; HB1 - Hebe Reef northwest; HB2 - Hebe Reef northeast; LH - Low Head; WH - West Head; BR - Barrel Rock; BH - Badger Head; SH - Stony Head; HO - Horseshoe Reef; DH - Don Heads; AP - Anniversary Point; SR - Sisters Rocks; BO - Boat Harbour; RC - Rocky Cape; WW - Waterhouse I. west; LW - Little Waterhouse I.; CP - North Croppies Pt; WP - Waterhouse Pt; NW - Waterhouse I. north.

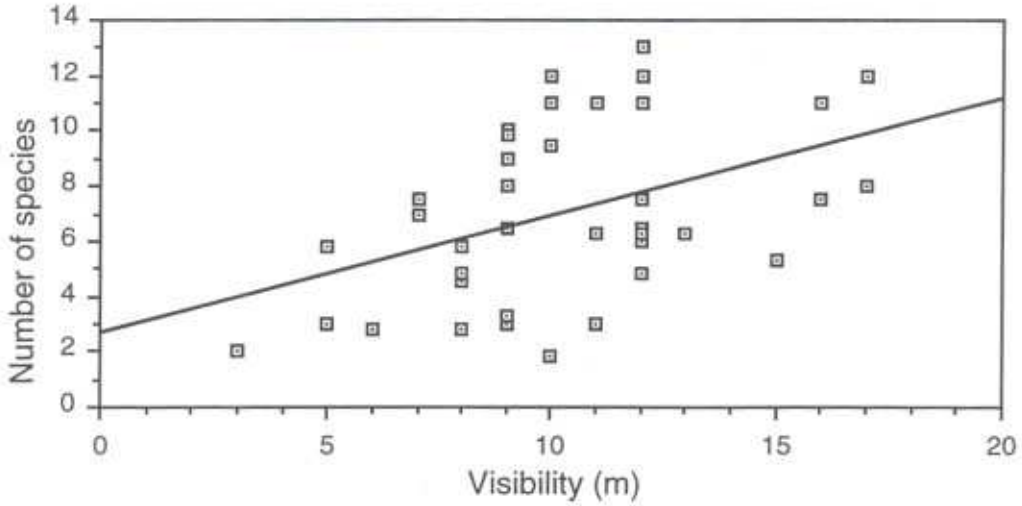

Fig. 5. Relationship between underwater visibility (V) and mean number of fish species (S) recorded at different sites during the study. The regression equation relating these parameters is $S=2.67+0.43*V$ ($r^2=0.194$).

Additional evidence indicating that the apparent loss of fish during July was caused by low visibility rather than oiling is that the sites not severely impacted by oil but with high turbidity in July (eg. Stony Head) also possessed very low numbers of fish species and individuals. Moreover, all fish assemblages with pronounced July shifts returned to predisturbance levels by the October surveys, and possessed numerous large-sized fish that could not have recruited within such a short period if massive mortality had occurred as a result of oiling. It is also notable that the July shifts in reef assemblages were confined to fishes and not sedentary invertebrates or plants, groups of organisms little affected by underwater visibility during visual censuses.

Comparison of Hebe Reef with coastal assemblages

The number of species recorded during 50 m transects at the two non-impact zone Hebe Reef sites were compared with data collected at the nearest six coastal sites using nested ANOVA (Table 1). Data used in these analyses were obtained during the 30 days immediately following the spill (19 July to 9 August 1995). The mean number of species at all sites censused during the study are shown in Figure 6, while the densities of abundant invertebrates, fishes and macroalgae are shown in Figs 7, 8 and 9. Abundant species shown in these figures and used in ANOVAs include animals from a great range of trophic categories (the planktivorous fish *Trachinops caudimaculatus*, the benthic-feeding fish *Notolabrus tetricus*, the suspension-feeding feather star *Comanthus trichoptera*, the herbivorous abalone *Haliotis ruber*, the detritivorous seastar *Tosia magnifica* and the carnivorous whelk *Thais orbita*).

Table 1. Results of ANOVA using data on number of species, the abundance of fish and invertebrates, and percent cover of macroalgae censused along 50 m transects. Abundance and percent cover were log (x+1) transformed. In this analysis the random factor *site* (df=6) was nested within *region* (northwest and northeast Hebe reef versus central coastal sites at West Head, Low Head, Barrel Rock, Badger Head, Stony Head, Horseshoe Reef; df=1). The number of degrees of freedom of the error term was 24. The mean values of the various parameters within the two regions are also shown. Tests were not possible for some species because of extreme heterogeneity of variances. *0.01<p<0.05, ** 0.001<p<0.01, ***0.001>p

	Sum of squares			F-ratio		Mean	
	Region	Site	Error	Region	Site	Hebe Reef	Coastal sites
Invertebrate species richness	5.04	96.8	21.0	0.31	18.40***	7.88	6.96
Algal species richness	10.0	101	103.3	0.59	3.92**	9.75	11.04
Fish species richness	19.3	70.7	90.8	1.63	3.12*	5.25	3.46
Total species richness	12.0	274	161	0.26	6.80***	22.88	21.46
Trachinops caudimaculatus	no test possible					6.27	0.72
Cheilodactylus nigripes	no test possible					0.30	0.03
Pictilabrus laticlavius	no test possible					0.49	0.17
Notolabrus fucicola	no test possible					1.54	0.44
Notolabrus tetricus	1.94	8.91	7.56	1.31	4.71*	8.17	4.19
Comanthus trichoptera	0.65	8.57	15.0	0.46	2.28	3.11	4.70
Heliocidaris erythrogramma	1.24	6.84	7.93	1.09	3.45*	31.88	50.83
Tosia australis	0.13	10.1	5.00	0.08	8.10***	1.54	1.94
Haliotis ruber	2.84	31.0	8.22	0.55	15.07***	7.77	3.41
Thais orbita	6.18	0.31	4.19	119.2***	0.30	2.70	0.34
Acrocarpia paniculata	8070	5570	7290	8.69*	3.06*	62.65	25.98
Cystophora moniliformis	6.97	10.1	19.4	4.14	2.08	5.52	1.22
Cystophora retroflexa	no test possible					0.89	2.26
Ecklonia radiata	no test possible					0.08	1.01
Seirococcus axillaris	0.03	16.5	12.4	0.01	5.32**	1.74	1.57
Zonaria spp.	2.77	20.7	7.82	0.80	10.60***	1.62	4.18

Table 2. Results of ANOVA using data on number of species, the abundance of fish and invertebrates, and percent cover of macroalgae censused along 50 m transects in the central Bass Strait region from Stony Head to Don Heads. Abundance and percent cover were log (x+1) transformed. Fixed factors analysed were *time* (before and after oil spill, i.e. 1994 versus October 1995) and *region* (heavily or moderately contaminated sites (Low Head, West Head and Barrel Rock) versus lightly or non-contaminated sites (Don Heads, Horseshoe Reef, Badger Head, Five Mile Bluff and Stony Head)). The random factor *site* nested within region was also incorporated in the analysis. Because of missing values, the degrees of freedom present in analyses varied for different parameters. Degrees of freedom = 1 for time, region and time*region effects, and is listed as df1 for site and time*site effects and df2 for the error term. The mean values of the various parameters within the putatively impacted region (Low Head, West Head and Barrel Rock) before and after the spill are also shown. Tests were not possible for some species because of extreme heterogeneity of variances. *0.01<p<0.05, ** 0.001<p<0.01, ***0.001>p

	Sum of squares								F-ratio					Mean	
Parameter examined	Time	Region	Time* Region	Site	Time* Site	Error	df1	df2	Time	Region	Time* Region	Site	Time* Site	Before	After
Invertebrate species richness	51.5	4.02	0.05	82.8	25.9	93.0	5	42	10.14*	0.24	0.01	7.48***	2.29	4.92	6.92
Algal species richness	0.05	42.9	2.30	209.7	42.7	171.3	6	48	0.01	1.23	0.32	9.80***	1.99	12.50	12.83
Fish species richness	48.9	0.02	32.6	323.9	47.8	192.0	6	47	6.13*	0.00	4.09	13.21***	1.95	6.50	6.17
Total species richness	0.86	84.3	42.0	824.7	63.0	460.0	5	42	0.07	0.51	3.33	15.06***	1.15	23.92	25.92
Trachinops caudimaculatus	No test possible													4.24	6.89
Cheilodactylus nigripes	No test possible													0.82	0.40
Pictilabrus laticlavius	4.77	1.08	0.32	9.62	1.89	9.22	6	47	15.14**	0.67	1.02	8.17***	1.61	2.43	1.31
Notolabrus fucicola	No test possible													1.55	1.35
Notolabrus tetricus	4.02	1.15	0.01	12.5	0.60	18.7	6	47	40.54***	0.55	0.06	5.25***	0.25	16.26	9.42
Comanthus trichoptera	2.90	0.18	0.12	21.8	1.56	26.9	5	42	9.29*	0.04	0.38	6.81***	0.49	3.41	5.97
Heliocidaris erythrogramma	0.02	0.00	0.01	23.5	0.20	29.3	5	42	0.50	0.00	0.18	6.73***	0.06	37.33	36.02
Tosia australis	No test possible													0.96	1.87
Haliotis ruber	No test possible													4.06	4.65
Thais orbita	No test possible													0.30	0.48
Acrocarpia paniculata	0.01	16.9	0.01	70.6	4.29	25.9	6	48	0.02	1.44	0.02	21.75***	1.32	12.83	13.52
Cystophora moniliformis	No test possible													0.89	6.98
Cystophora retroflexa	2.54	0.00	0.52	37.8	2.97	29.7	6	48	5.13	0.00	1.05	10.16***	0.80	4.74	6.93
Ecklonia radiata	No test possible													5.22	2.93
Seirococcus axillaris	No test possible													1.26	0.93
Zonaria spp.	6.25	1.16	8.04	23.9	7.21	12.9	6	48	5.20	0.30	6.69*	14.48***	4.49**	5.49	4.71

Table 3. Results of ANOVA using data on number of species, the abundance of fish and invertebrates, and percent cover of macroalgae censused along 50 m transects in the central Bass Strait region from Waterhouse Point to Rocky Cape. Abundance and percent cover were log (x+1) transformed. Fixed factors analysed were *time* (before and after oil spill, i.e. 1994 versus October 1995) and *region* (putatively contaminated sites (Low Head, West Head, Barrel Rock, Badger Head and Five Mile Bluff) versus non-contaminated sites (Rocky Cape, Anniversary Point, Sisters Rocks, Boat Harbour, Don Heads, Horseshoe Reef, Stony Head, Waterhouse Island north, Waterhouse Island west, Little Waterhouse Island, Croppies Point, Little Waterhouse Island). The random factor *site* nested within region was also incorporated in the analysis. Because of missing values, the degrees of freedom present in analyses varied for different parameters. Degrees of freedom = 1 for time, region and time*region effects, and is listed as df1 for site and time*site effects and df2 for the error term. The mean values of the various parameters within the putatively impacted region (Low Head, West Head, Barrel Rock, Badger Head, Five Mile Bluff and Stony Head) before and after the spill are also shown. Tests were not possible for some species because of extreme heterogeneity of variances. *0.01<p<0.05, ** 0.001<p<0.01, ***0.001>p

	Sum of squares								F-ratio					Mean	
Parameter examined	Time	Region	Time* Region	Site	Time* Site	Error	df1	df2	Time	Region	Time* Region	Site	Time* Site	Before	After
Invertebrate species richness	9.84	10.2	78.6	212.9	53.1	186.5	12	84	2.22	0.57	17.76***	7.99***	1.99*	3.75	6.90
Algal species richness	4.20	83.7	22.9	425.5	122.2	512.0	13	90	0.45	2.56	2.43	5.75***	1.65	12.30	11.90
Fish species richness	114.6	319.4	0.02	487.6	176.9	820.5	15	101	9.72**	9.83**	0.00	4.00***	1.45	6.65	6.05
Total species richness	15.2	653.2	37.0	1283.6	259.9	1329.3	12	84	0.70	6.11*	1.71	6.76***	1.37	19.05	24.85
Trachinops caudimaculatus	no test possible													10.29	11.87
Cheilodactylus nigripes	no test possible													1.33	0.40
Pictilabrus laticlavius	7.98	0.74	0.34	27.2	5.4	25.5	15	101	22.10***	0.41	0.93	7.17***	1.43	2.23	1.07
Notolabrus fucicola	no test possible													0.83	0.92
Notolabrus tetricus	7.45	21.5	0.05	31.6	2.3	28.8	15	101	47.55***	10.22**	0.29	7.38***	0.55	14.41	9.30
Comanthus trichoptera	0.00	0.25	6.43	110.7	11.9	56.0	12	84	0.00	0.03	6.44*	13.83***	1.50	2.98	8.45
Heliocidaris erythrogramma	1.90	2.71	1.69	76.3	12.3	60.2	12	84	1.86	0.43	1.65	8.88***	1.43	20.35	36.80
Tosia australis	no test possible													0.50	1.20
Haliotis ruber	0.95	0.02	0.04	67.8	14.3	43.9	12	84	0.80	0.00	0.03	10.81***	2.28*	1.87	2.07
Thais orbita	no test possible													0.27	0.78
Acrocarpia paniculata	3.19	1.46	2.69	102.5	30.8	57.3	13	90	1.35	0.18	1.13	12.39***	3.72***	24.46	23.58
Cystophora moniliformis	0.11	11.8	0.35	51.2	20.2	78.3	13	90	0.07	3.00	0.22	4.52***	1.79	3.00	4.42
Cystophora retroflexa	8.51	5.02	0.03	71.1	15.5	50.7	13	90	7.14*	0.92	0.03	9.70***	2.11*	5.15	8.58
Ecklonia radiata	no test possible													2.44	2.23
Seirococcus axillaris	no test possible													2.72	2.80
Zonaria spp.	13.3	1.49	0.05	37.9	24.6	35.7	13	90	7.02*	0.51	0.02	7.36**	4.77***	3.62	5.58

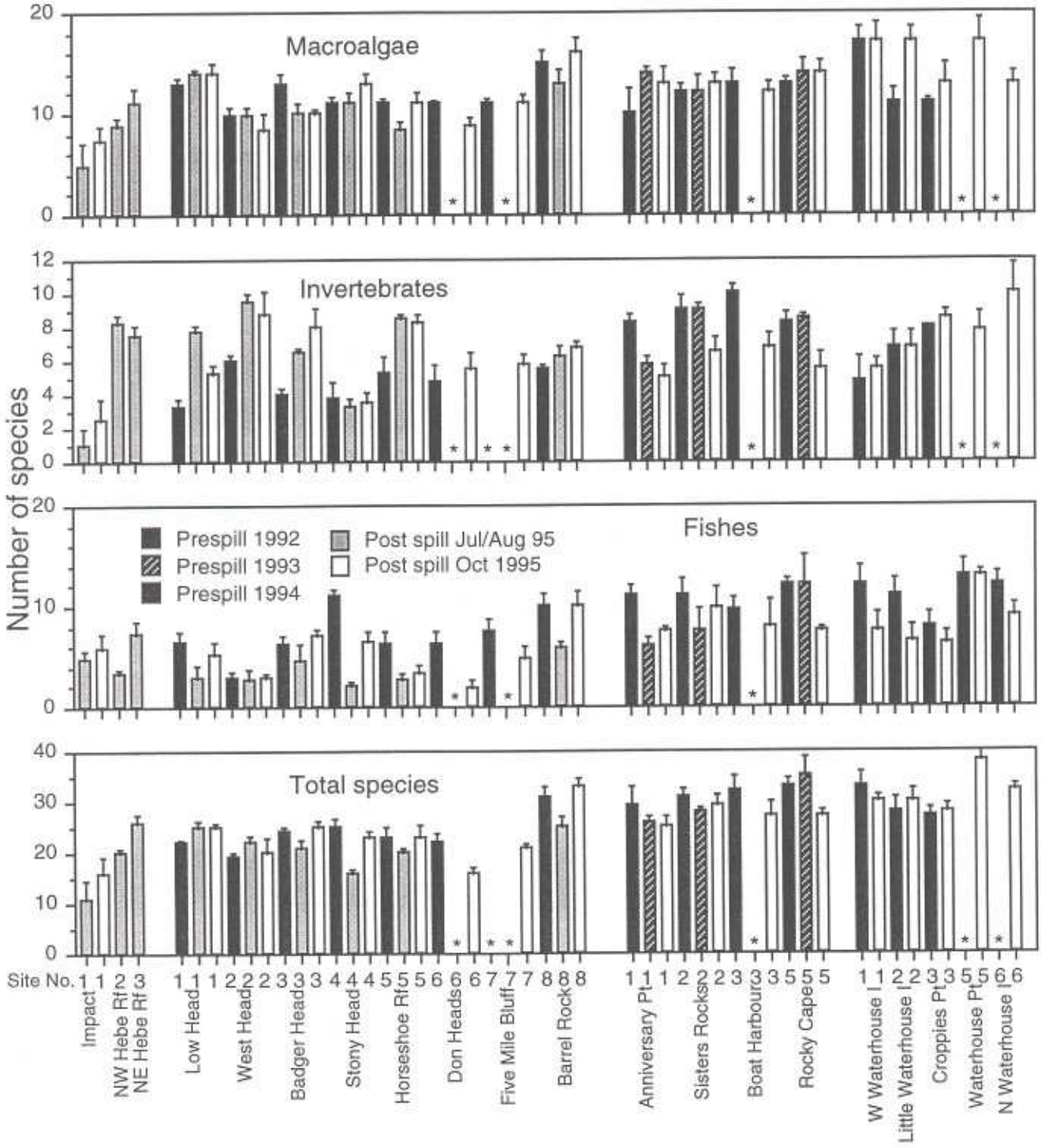

Fig. 6. Mean number of species recorded per transect at different sites. Error bars indicate standard error of the mean. *sites not censused.

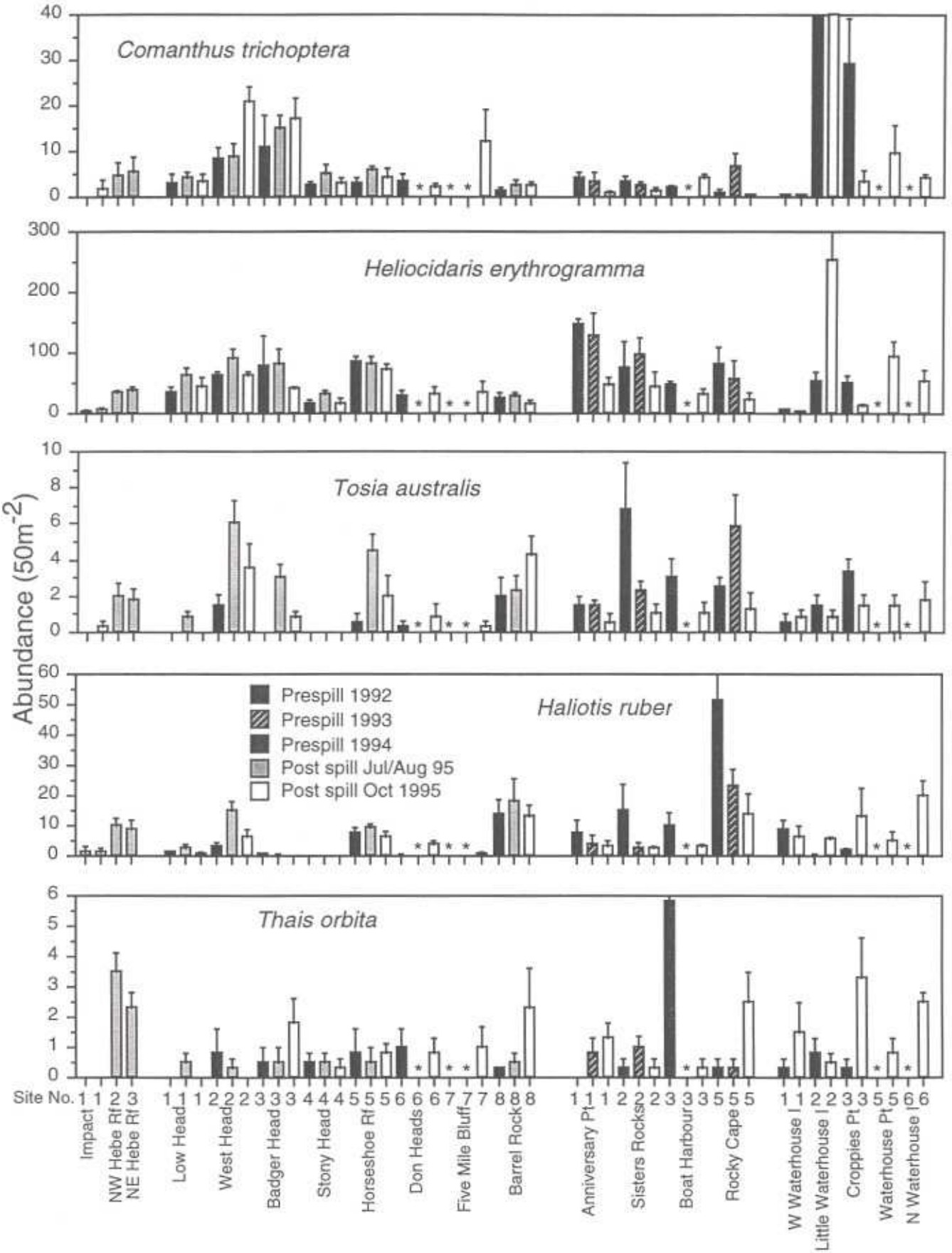

Fig. 7. Mean abundance of the most common invertebrate species recorded per transect at different sites. Error bars indicate standard error of the mean. *sites not censused.

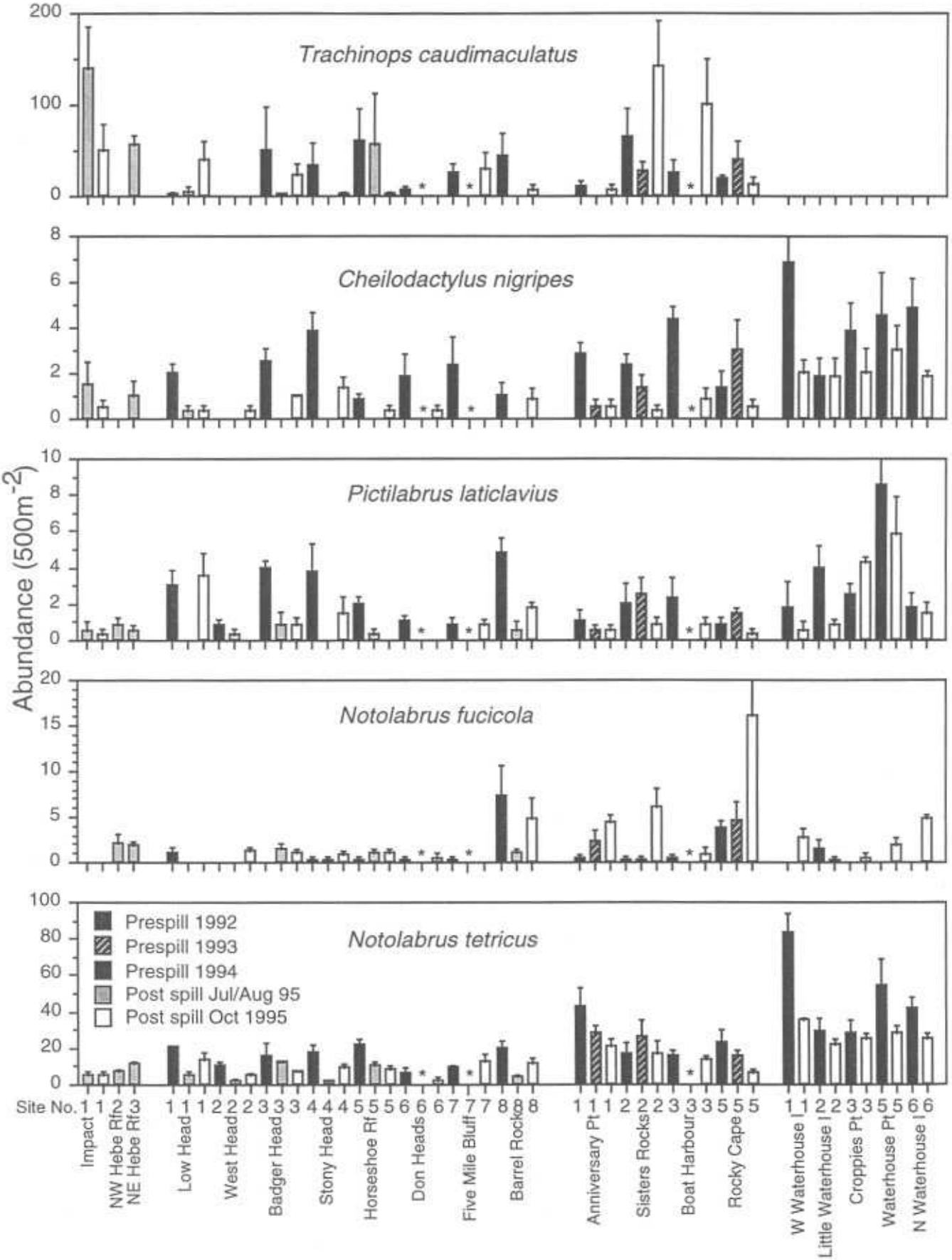

Fig. 8. Mean abundance of the most common fish species recorded per transect at different sites. Error bars indicate standard error of the mean. *sites not censused.

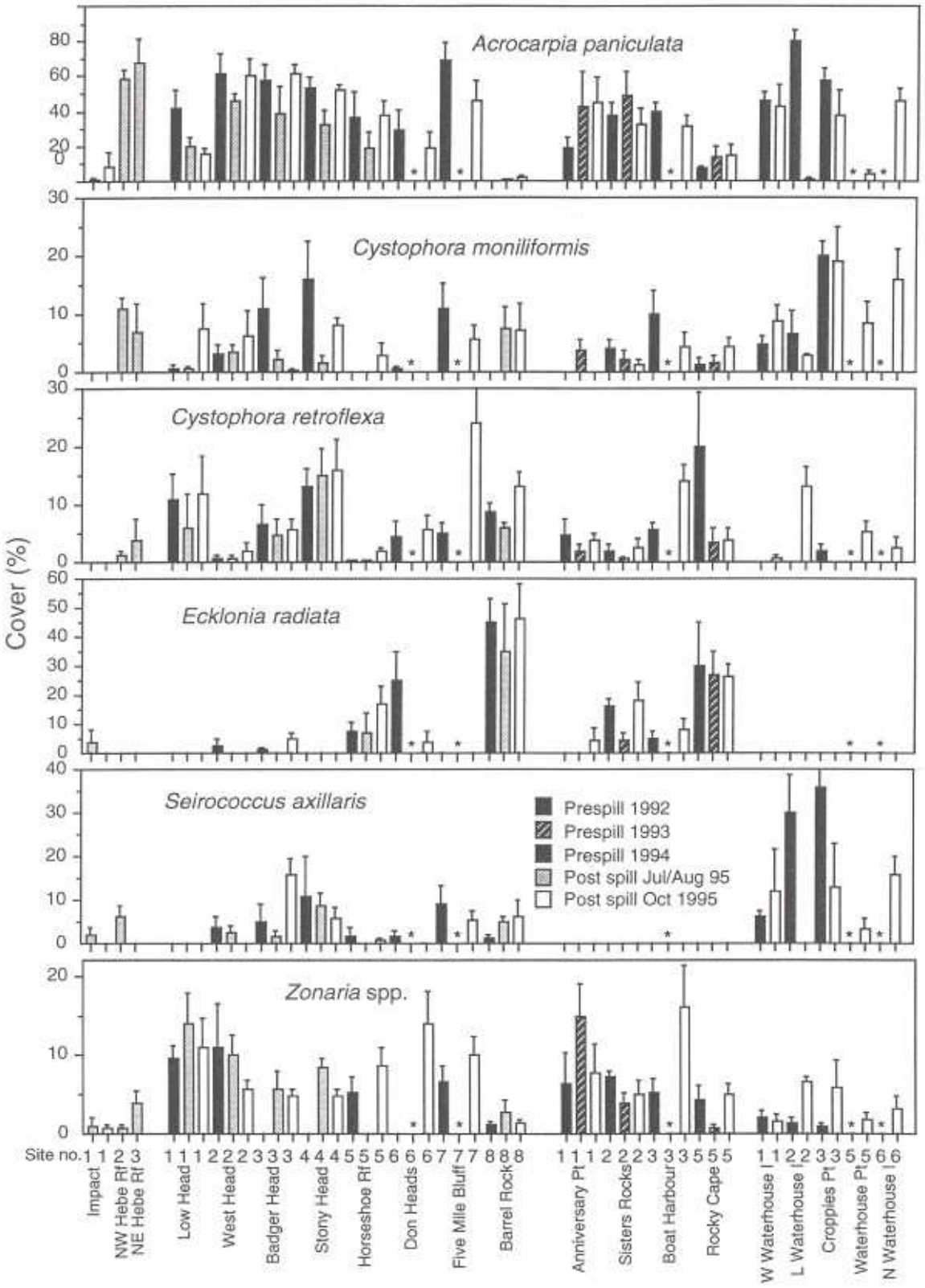

Fig. 9. Mean percentage cover of the most common plant species recorded per transect at different sites. Error bars indicate standard error of the mean. *sites not censused.

No significant differences in number of species per transect were detected for invertebrates, fishes or macroalgae when data were analysed independently, nor when total number of species in the three groups were combined together (Table 1). Furthermore, none of the most abundant species observed on reefs occurred in significantly greater abundance on coastal reefs than at Hebe Reef, as would be expected if substantial mortality had occurred at Hebe Reef following the oil spill. Two species (the gastropod *Thais orbita* and the large fucoid alga *Acrocarpia paniculata*) were more abundant at Hebe Reef than at the coastal sites (Table 1).

Because of limited censusing and a lack of prespill data from Hebe Reef, the ANOVAs used for these comparisons had low power, so it is possible that oil-induced effects occurred at Hebe Reef but were not detected at statistically significant levels. Formal power analyses have not been calculated here but the mean data shown in Table 1 and Figs 7, 8 and 9 indicate that a three- to fivefold difference is needed between regions to produce a significant test result. All of the common invertebrate and fish species nevertheless possessed equivalent or substantially higher population densities at Hebe Reef than on the Tasmanian coast (Table 1), contrary to the trend expect if oil adversely affected communities. Three macroalgal taxa (*Cystophora retroflexa, Ecklonia radiata* and *Zonaria* spp.) covered a substantially higher proportion of the reef surface on the coast than at Hebe Reef; however, this probably resulted from *Acrocarpia paniculata* monopolising such a high proportion of the substratum at Hebe Reef rather than the effects of oil.

A lack of significance in the various tests shown in Table 1 does not indicate that Hebe Reef sites were not impacted by oil as similar changes may perhaps have also occurred at coastal sites. If this had happened then no differences between regions would have been detected. Accordingly, comparisons were made of population densities in the moderately- and heavily-oiled coastal region versus other sites on the central north coast.

Comparison of heavily-oiled sites with lightly-oiled or non-oiled sites

The mean densities of organisms generally changed little within the moderately and heavily-oiled coastal region (Low Head, West Head and Barrel Rock sites) from 1994 to 1995, with 12 of the 20 parameters examined exhibiting an increase in mean density over this period (Table 2). The results of nested ANOVAs comparing changes following the spill at the three heavily- and moderately-oiled sites with adjacent lightly- or non-oiled sites (Table 2) identified only one parameter (percent cover of *Zonaria*) with a significant site*time interaction. The significant result in this case was largely due to an increase in density outside the impacted area. Within the putatively oiled area, the change in *Zonaria* density was relatively slight (a decline from 5.5% to 4.7% cover).

Two parameters (the abundance of the wrasses *Pictilabrus laticlavius* and *Notolabrus tetricus*) decreased significantly at all sites analysed in the central Bass Strait region (Table 2), a result consistent with the hypothesis that the spill affected lightly- as well as heavily-oiled sites . To test this hypothesis, data from the central Bass Strait region were compared with data from control sites outside this region (Table 3). This analysis indicated that *Pictilabrus laticlavius*

and *Notolabrus tetricus* decreased in abundance on all Bass Strait reefs over the period of the study, rather decreasing within oiled sites only.

Two parameters (invertebrate species richness and abundance of the feather star *Comanthus trichoptera*) showed a significant time*region interaction in the larger regional analysis (Table 3). This is the predicted result if oil significantly affected the reef biota in the central Bass Strait region; however, densities increased within the putatively impacted area for both of these parameters, contrary to predictions of a negative effect.

CONCLUSIONS

The grounding of the *Iron Baron* on Hebe Reef resulted in the complete destruction of the subtidal reef community within an area of ≈170 m by ≈20 m, presumably largely because of physical abrasion from the ship's hull. The release of large quantities of fuel oil during the grounding does not appear to have substantially affected populations of subtidal reef-associated organisms, neither at Hebe Reef nor on reefs at the mouth of the Tamar estuary where large quantities of oil washed ashore. Analyses of changes over time at oil-affected sites before and after the spill, and comparisons with adjacent control sites, indicate no significant change in number of species on reefs nor in the densities of the most abundant animal and plant species. If population changes have occurred as a result of the spill, then these must either be confined to the rarer species or be relatively slight (less than a 50% change in density). Given the high level of natural variability on reefs, communities would be expected to recover from any such effects within a short period.

RECOMMENDATIONS

Because plant and animal communities on coastal reefs do not appear to have been greatly affected by the release of oil from the *Iron Baron* , further monitoring of coastal reef communities is considered unnecessary. Limited monitoring of the impact zone at Hebe Reef is, however, recommended in order to identify the timescale required for assemblages in this region of complete destruction to recover. A resurvey of this site plus the two nearby control sites on Hebe Reef should be carried out early in 1996, with an additional resurvey conducted 12 months after the impact in July 1996 if the earlier survey shows little recovery to have taken place amongst the macroalgal and invertebrate assemblages. We nevertheless recognise that this region of disturbance is relatively localised, so can be accorded a relatively low priority in the overall oil spill monitoring program.

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Appendix. Mean density data for the various sites examined, with species codes, location codes and dates. Due to space limitations, standard deviations of replicates at each site are not shown. On average, $SD/\bar{x} = 1.4$.

Area	Site	Date	Invertebrate species code																				Location
			200	201	202	204	205	206	208	209	210	211	212	213	214	215	216	217	218	220	221	222	226	
1	1	9-Aug-95	0	0	3.5	0	0	0	0	0	0	0	0	0	0.3	0	0	0	0	0	0	0	0	Impact site
1	1	22-Oct-95	1.75	0	5	0	0	0	0	0	0.3	0	0	0	0	0	0.3	0	0	0	0	0	0	Impact site
1	2	8-Aug-95	4.5	1	33	0.3	0	0	0.5	0	0	0	0	1	0.8	0	2	0.3	0	0	0	0	0	Northwest Hebe Rf
1	3	9-Aug-95	4.25	0.5	22.5	0	0	0	0.3	0	0	0.3	0	0.3	0	0	1	0.3	0	0	0	0	0	Northeast Hebe Rf
2	1	11-Apr-94	3	0	33.3	0	0	0	0	0.3	0	0	0.3	0	0	0	0	0.3	0	0	0	0	0	Low Head
2	1	19-Jul-95	4	3.3	64	0	0	0	0	0	0	0	0.5	0	0.3	0	0.8	0.3	0	0	0	0	0	Low Head
2	1	4-Oct-95	3.75	0.5	43.5	0	0	0	0.3	0.3	0	0	0.5	0	0.5	0	0	0.3	0	0	0	0	0	Low Head
2	2	12-Apr-94	8.5	1.8	62.3	0	0	0	0.3	0	0	0	0	0	0	0	1.5	0.3	0	0	0	0	0	West Head
2	2	21-Jul-95	8.75	2	91.8	0.3	0	0	0	0.3	0	1.3	0.8	0	0.5	0	6	0	0.3	0	0.3	0	0.3	West Head
2	2	22-Oct-95	20.5	14	63.3	0	0	0	0	0.8	0	0.5	0.3	0	0.3	0	3.5	0.5	0	0	1	2.3	0	West Head
2	8	19-Oct-94	1.25	0	25	0	0	0	0	0	0	0.5	0	0	0	0	2	0.3	0	0	0	0	0	Barrel Rock
2	8	22-Jul-95	2.25	0	26.5	0	0	0.3	0	0	0	0.8	0.3	0.3	0	0	2.3	0	0	0	0	0	0	Barrel Rock
2	8	22-Oct-95	2.5	0	16.8	0.8	0	0	0	0	0	0.3	0	0	0	0	4.3	1.5	0	0	0	0	0	Barrel Rock
2	3	12-Apr-94	10.8	0	77.8	0	0	0	0	0	0.3	0	0	0.5	0.8	0	0	0.3	0	0	0	0	0	Badger Head
2	3	21-Jul-95	14.5	0.8	81.3	0.3	0	0	0.3	0	0	0	0	0.5	0.8	0	3	0.3	0.3	0	0	0	0	Badger Head
2	3	21-Oct-95	16.5	1.8	41.3	0	0	0	0	0.3	1	0	0	0.5	0	0	0.8	0.8	0	0	0	0	0	Badger Head
2	4	13-Apr-94	2.25	0.3	16.3	0	0	0	0.3	0	0	0	0	0.5	0.3	0	0	0	0	0	0	0	0	Stony Head
2	4	22-Jul-95	4.75	0	31.8	0	0	0	0.5	0	0	0	0	0	0.3	0	0	0	0	0	0	0	0	Stony Head
2	4	20-Oct-95	3	0	15.8	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	Stony Head
2	5	14-Apr-94	3	0.3	84.3	0	0	0	0	0	0	0	0	0.5	0	0	0.5	0.5	0	0	0	0	0	Horseshoe Reef
2	5	20-Jul-95	5.75	2.5	81.8	0	0	0	0.5	0	0	0	0.8	0.5	0.5	0	4.5	1.8	0	0	0	0	0	Horseshoe Reef
2	5	20-Oct-95	4.25	2.3	71.8	0	0	0	0.3	0.3	0.3	0	0	0.5	0.3	0	2	1.5	0	0	0	0	0	Horseshoe Reef
2	6	14-Apr-94	3.25	1.8	27	0	0	0	0	0	0	0	0	0	0.3	0	0.3	0	0	0	0	0	0	Don Heads
2	6	20-Oct-95	2	0.3	31.8	0	0	0	0	0	0	0	0	0	0	0	0.8	0.3	0	0	0	0	0	Don Heads
2	7	4-Oct-95	11.8	3.5	35	0	0	0	0	0.3	0.3	0	0.3	0	0.5	0	0.3	0	0	0	0.3	0	0	Five Mile Bluff
3	1	23-May-92	4	0	147	0	0	0	0	0	0.3	0	0	0	1.3	0	1.5	1.3	0	0	0	0	0	Anniversary Pt
3	1	9-Jun-93	3.5	0.3	129	0	0.3	0	0	0	0	0	0	0	0	0	1.5	0.3	0	0	0	0	0	Anniversary Pt
3	1	29-Oct-95	0.75	0	45.5	0	0	0	0	0	0	0	0	0	0.5	0	0.5	0	0	0	0	0	0	Anniversary Pt
3	2	23-May-92	3.25	0	74.8	0.3	0	0	0.3	0	0	0	0	1.5	1	0	6.8	0	0	0	0	0	0	Sisters Rocks
3	2	9-Jun-93	2.25	0	95.8	0	0	0	0	0	0	0	0.5	1	1.3	0	2.3	0.5	0	0	0	0	0	Sisters Rocks
3	2	30-Oct-95	1.25	0	45.3	0	0	0	0	0	0.3	0	0	0.8	0.8	0	1	0.3	0	0	0	0	0	Sisters Rocks
3	3	24-May-92	2	0	46	0	0	0	0	0	0	0	0.3	0	0.5	0	3	0.8	0	0	0	0	0	Boat Harbour
3	3	30-Oct-95	4	0.5	31	0	0	0	0	0	0.3	0	0	0	0.5	0	1	0	0	0	0	0	0	Boat Harbour
3	4	25-May-92	1	0	82.3	0	0	0	0	0	0	0	0.3	0.3	2.3	0	2.5	0.8	0	0	0	0	0	Rocky Cape
3	4	9-Jun-93	6.75	0	57	0	0	0	0	0	0.5	0	0	0.3	1.3	0	5.8	1	0	0	0	0	0	Rocky Cape
3	4	30-Oct-95	0.25	0	20.8	0	0	0	0	0	0	0.3	0	0.3	1	0	1.3	0	0	0	0	0	0	Rocky Cape
4	1	23-Apr-92	0.25	0	5	0	0	0	0	0	0.3	0.3	0	0	0.5	0	0.5	0.3	0	0	0	0	0	West Waterhouse I.
4	1	23-Oct-95	0.25	0	3	0	0	0	0.3	0	0	1	0	0.5	1	0	0.8	0	0	0	0	0	0	West Waterhouse I.
4	2	24-Apr-92	142	0	53.5	0.3	0	0.3	0	0	1.3	0	0	0.3	0.3	0	1.5	0.3	0	0	0	0	0	Little Waterhouse I.
4	2	23-Oct-95	81.5	0	253	0	0	0	0.3	0	0.5	0	0	0	0.8	0	0.8	0	0	0	0	0	0	Little Waterhouse I.
4	3	25-Apr-92	29	0	49.3	0	0	0	0	0	0.3	1	0.3	0	2.3	0.3	3.3	0	0	0	0	0	0	North Croppies Pt
4	3	24-Oct-95	3.5	0	12.3	0	0	0	0.3	0	0	1.3	0	0.3	0.3	0	1.5	0.3	0	0	0	0	0	North Croppies Pt
4	4	24-Oct-95	9.5	0	94.3	0.3	0	0	0	0	1.5	4.8	0.3	0.3	0.3	0	1.5	0	0	0	0	0	0	Waterhouse Pt
4	5	23-Oct-95	4	0.5	53.5	0.3	0	0	0	0	0.8	2.3	0.3	1.3	0.8	0	1.8	0	0	0	0	0	0	Nth Waterhouse I.
		Species	*Comanthus trichoptera*				*Goniocidaris tubaria*					*Petricia vernicina*					*Uniophora granifera*					*Paranepanthia grandis*	
				Comanthus tasmaniae				*Austrofromia polypora*				*Pentagonaster dubeni*					*Stichopus mollis*						
					Heliocidaris erythrogramma				*Coscinasterias muricata*				*Plectaster decanus*				*Amblypneustes sp.*						
						Holopneustes inflatus				*Nectria ocellata*				*Tosia magnifica*					*Patiriella calcar*				
							Amblypneustes spp.				*Patiriella brevispina*				*Tosia australis*						*Nepanthia troughtoni*		
		Code no.	200	201	202	204	205	206	208	209	210	211	212	213	214	215	216	217	218	220	221	222	226	

Area	Site	Date	Invertebrate species code																				Location
			228	232	234	240	241	242	243	244	247	249	250	251	252	253	257	259	270	271	272	273	274	
1	1	9-Aug-95	0	0	0	0	1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Impact site
1	1	22-Oct-95	0	0	0	0	1.3	0	0	0	0	0	0	0	0	0	0.3	0	0	0.3	0	0	0	Impact site
1	2	8-Aug-95	0.3	0	0	0	10	0	0	0	0	0	3.5	0.3	0	0	0	0	0	0.3	0	0	0	Northwest Hebe Rf
1	3	9-Aug-95	0	0	0	0	6.5	0	0	0	0	0	1.5	0	0	0	0	0	0	0	0	0	0.3	Northeast Hebe Rf
2	1	11-Apr-94	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.3	Low Head
2	1	19-Jul-95	0	0	2.3	0	2.5	0	0	0	0	0	0.5	0	0	0	0.3	0	0.3	0.3	0	0.3	0	Low Head
2	1	4-Oct-95	0	0	0	0	0.8	0	0.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0.3	Low Head
2	2	12-Apr-94	0	0	0	0.5	3.3	0	0	0	0	0	0.8	0	0	0	0	0	0	0	0	0	0	West Head
2	2	21-Jul-95	0	0	0	0.3	15	0	0.3	0	0	0	0.3	0	0	0	0	0.3	0	0.3	0	0	0.3	West Head
2	2	22-Oct-95	0	0	0	0.8	6.5	0	0.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0.3	West Head
2	8	19-Oct-94	0	0	0	4	14	0.3	0	0	0	0	0.3	0	0	0	0	0	0	0	0	0	0	Barrel Rock
2	8	22-Jul-95	0	0	0	2	18	0	1.3	0	0	0	0.5	0	0	0	0	0	0	0.3	0	0	0	Barrel Rock
2	8	22-Oct-95	0	0	0	3.5	13	0	0	0	0	0	2.3	0	0	0	0.3	0	0	0	0	0	0	Barrel Rock
2	3	12-Apr-94	0	0	0	0	0.5	0	0	0	0	0	0.5	0	0	0	0	0	0	0	0	0	0	Badger Head
2	3	21-Jul-95	0	0.3	0	0	0.3	0	0	0	0	0	0.5	0	0	0	0	0	0	0	0	0	0.3	Badger Head
2	3	21-Oct-95	0	0	0	0	0	0	0	0	0	0	1.8	0.5	0	0	0	0	0.3	0	0.8	0	1	Badger Head
2	4	13-Apr-94	0	0	0	0	0	0	0.3	0	0	0	0.5	0	0	0	0	0	0	0	0	0	0	Stony Head
2	4	22-Jul-95	0	0	0	0	0	0	0	0	0	0	0.5	0	0	0	0	0	0	0	0	0	0.3	Stony Head
2	4	20-Oct-95	0	0	0	0	0	0	0	0.3	0	0	0.3	0	0	0	0	0	0	0	0.3	0	0.5	Stony Head
2	5	14-Apr-94	0	0	0	0	7.3	0	0	0	0.3	0	0.8	0	0	0	0	0	0	0	0	0	0.3	Horseshoe Reef
2	5	20-Jul-95	0	0	0	0	9.3	0	0	0	0	0	0.5	0	0	0	0	0	0	0	0.3	0	0	Horseshoe Reef
2	5	20-Oct-95	0	0	0	0	6.3	0.3	0.5	0	0	0	0.8	0	0	0	0	0	0	0	0	0	0	Horseshoe Reef
2	6	14-Apr-94	0	0	0	0	0.3	0	5	0	0	0	1	0	0	0	0	0	0	0	0	0	1	Don Heads
2	6	20-Oct-95	0	0	0	15	3.8	0	1.3	0	0	0	0.8	0	0	0	0.3	0	0	0	0	0	0.3	Don Heads
2	7	4-Oct-95	0	0	0	0	0.5	0	0.5	0	0	0	1	0.3	0	0	0	0	0	0	0	0	0	Five Mile Bluff
3	1	23-May-92	0	0	0	1	7.3	0.3	0	0.3	0	0	0	0	1.5	1.3	0.3	0	0	0.3	0	0	0.8	Anniversary Pt
3	1	9-Jun-93	0	0	0	2.3	3.5	0.8	0	0	0	0	0.8	0	0	0	0	0	0	0	0.5	0	0	Anniversary Pt
3	1	29-Oct-95	0	0	0	0.3	3	0.8	0.3	0	0	0	1.3	0	0	0	0	0	0.3	0	0	0	0	Anniversary Pt
3	2	23-May-92	0	0	0	0	15	0.5	0	0	0	0	0.3	0	0	0.3	0	0	0	0.5	1.5	0.3	0.8	Sisters Rocks
3	2	9-Jun-93	0	0	0	0	2.3	0.3	0	0	0	0	1	0	0	0	0	0	0	1.3	0.8	0.3	1.5	Sisters Rocks
3	2	30-Oct-95	0	0	0	0	2.3	0	0	0	0	0	0.3	0.5	0	0	0	0	0	0	0	0	1	Sisters Rocks
3	3	24-May-92	0	0	0	0	10	2.3	3.8	0.5	0	0	5.8	0	0	0	0.5	0	0.8	0	0.8	0	4.3	Boat Harbour
3	3	30-Oct-95	0	0	0	0	3.3	0.3	0	0	0.3	0	0.3	0.3	0	0	0	0	0.3	0	0.3	0	0.5	Boat Harbour
3	4	25-May-92	0	0	0	0	51	1.3	1	0	0	0.3	0.3	0	0	0	0	0	0	0.3	0.3	0	4.3	Rocky Cape
3	4	9-Jun-93	0	0	0	0	23	0	0	0.8	0	0	0.3	0	0	0	0	0	0	0	1.5	0	1.5	Rocky Cape
3	4	30-Oct-95	0	0	0	0.3	14	0.3	0	0	0	0	2.5	0	0	0	0	0	0	0	0.5	0	0.3	Rocky Cape
4	1	23-Apr-92	0	0	0	0	8.5	0	0.3	0	0	0	0.3	0	0	0	0	0	0	0	1.8	0	0	West Waterhouse I.
4	1	23-Oct-95	0	0	0	0	6	0	0	0	0	0	1.5	0	0	0	0	0	0	0	0.3	0	0	West Waterhouse I.
4	2	24-Apr-92	0	0	0	0	0.3	0	0	0	0	0	0.8	0	0	0	0.5	0	0	0	1	0	0.8	Little Waterhouse I.
4	2	23-Oct-95	0	0	0	1.8	5.5	0	0	0	0	0	0.5	0	0	0	0	0	0	0	0.3	0	0.3	Little Waterhouse I.
4	3	25-Apr-92	0	0	0	0	2	0.5	0.3	0	0	0	0.3	0	0	0	0	0	0.3	0.5	0.5	0	0.3	North Croppies Pt
4	3	24-Oct-95	0	0	0	0.8	13	0.3	5.8	0	0	0	3.3	0	0	0	0	0	0	0	2	0	0	North Croppies Pt
4	4	24-Oct-95	0	0	0	4	5.3	0	0	0	0	0	0.8	0.3	0	0	0	0	0	0	1.3	0	0	Waterhouse Pt
4	5	23-Oct-95	0	0	0	0.5	20	0	0.5	0	0	0	2.5	0	0	0	0	0	0	0	1.3	0	0.5	Nth Waterhouse I.

		Species					*Haliotis ruber*				*Chlamys asperrimus*						*Cymatium spengleri*						*Trizopagurus strigimanus*
			Allostichaster polyplax					*Pleuroploca australasia*				*Thais orbita*						*Octopus sp.*					Unidentified pagurid
				Smilasterias multipara					*Turbo undulatus*				*Sepia aparma*						*Jasus edwardsii*				
										Penion mandarinus				*Haliotis emma*							*Nectocarcinus tuberculatus*			
						Haliotis laevigata					*Cabestana tabulata*				*Ranella australasia*						*Plagusia chabrus*			
		Code	228	232	234	240	241	242	243	244	247	249	250	251	252	253	257	259	270	271	272	273	274	

Area	Site	Date	Fish species code																	Location
			1	3	4	6	9	21	23	25	27	28	29	34	35	39	40	41	43	
1	1	9-Aug-95	0	0	0	0	0.5	0	0	7.5	140	0	0	0	0	0	0	0	0	Impact site
1	1	22-Oct-95	0	0	0	0	0	0	0	18	50.5	0	0	0	0	0.3	1	0	0	Impact site
1	2	8-Aug-95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Northwest Hebe Rf
1	3	9-Aug-95	0	0	0	0	0	0.3	0	0.3	56	0	0	0	0	0	0	0	0.8	Northeast Hebe Rf
2	1	11-Apr-94	0	0	0	0	0	0	0	0	2.25	0	0	0.3	0	0	0	0	0	Low Head
2	1	19-Jul-95	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	Low Head
2	1	4-Oct-95	0	0	0	0	0	0	0	0	40	0	0	0	0	0	0	0	0	Low Head
2	2	12-Apr-94	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0	0	0	West Head
2	2	21-Jul-95	0	0	0	0	0	0	0	0	0.25	0	0	0	0	0	0	0	0	West Head
2	2	22-Oct-95	0	0	0	0	0	0	0	0	0.5	0	0	0	0	0	0	0	0	West Head
2	8	19-Oct-94	0	0	0	0	0	0	0	0	43.3	0	0	0	0	5	2.5	0	0	Barrel Rock
2	8	22-Jul-95	0	0	0	0.25	0	0	0	0	0	0	0	0	0	0	0.3	0	0	Barrel Rock
2	8	22-Oct-95	0	0	0	0	0	0	0	0	7	0	0.3	0	0	12	0.3	0	0	Barrel Rock
2	3	12-Apr-94	0	0	0	0	0	0	0	0	51	11	0	0.3	0	0	0	0	0	Badger Head
2	3	21-Jul-95	0	0	0	0	0	0.3	0	0.3	1.5	0	0	0	0	0	0	0	0	Badger Head
2	3	21-Oct-95	0	0	0	0	0	0	0	0	22.8	0	0	0	0	0.5	0	0	0	Badger Head
2	4	13-Apr-94	0	0	0	0	0	0	0.3	0	33.3	0	0	0.8	0.5	0	2.8	0	0	Stony Head
2	4	22-Jul-95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.3	Stony Head
2	4	20-Oct-95	0	0	0	0	0	0	0	0	2.75	0	0	0	0.3	0	2.8	0	0	Stony Head
2	5	14-Apr-94	0	0	0	0	0	0	0	2.8	60.5	0	0	0	0	0	0	0	0	Horseshoe Reef
2	5	20-Jul-95	0	0	0	0	0	0	0	0	57.3	0	0	0	0	0	0	0	0	Horseshoe Reef
2	5	20-Oct-95	0	0	0	0	0	0	0	0	2.25	0	0	0	0	0	0	0	0	Horseshoe Reef
2	6	14-Apr-94	0	0	0	0	0.25	0	0	0	6.25	0	0	0	120	0	0	0	0	Don Heads
2	6	20-Oct-95	0	0	0	0	0	0	0	0	0.5	0	0	0	0	0	0	0	0	Don Heads
2	7	13-Apr-94	0	0	0	0	0.33	0	0	0	31.3	8.7	0	0.3	40	0	3	0.3	0	Five Mile Bluff
2	7	4-Oct-95	0	0	0	0	0	0	0	0	29.3	0	0	0	0	0	0.8	0	0	Five Mile Bluff
3	1	23-May-92	0	0	0	0	0.25	0	0	34	10.5	0	0	0.5	0	0	0	0	0	Anniversary Pt
3	1	9-Jun-93	0	0	0	0	0	0	0	1.5	0	0	0	0	0	2.8	0	0	0	Anniversary Pt
3	1	29-Oct-95	0	0.3	0	0	0	0	0	3.8	6.25	0	0.3	0	0	0	0.5	0	0	Anniversary Pt
3	2	23-May-92	0	0	0	0	0	0	0	3.8	64	0	0	0.5	135	0	0.8	0	0	Sisters Rocks
3	2	9-Jun-93	0	0	0	0	0	0	0	0	27.8	21	0	0.3	24	0	0	0	0.3	Sisters Rocks
3	2	30-Oct-95	0	0	0	0	0.5	0	0.3	1.5	142	0	0	0.3	0.3	0	1	0	0	Sisters Rocks
3	3	24-May-92	0	0	0	0	0	0	0	0.8	24.3	0	0	1	305	0.5	0.3	0	0	Boat Harbour
3	3	30-Oct-95	0	0	0	0	0	0	0	1.8	100	1.8	0	0	1	7.5	0.3	0	0	Boat Harbour
3	4	25-May-92	0	0	0	0	0.25	0	0	10	18	0	0	0.8	27	0	2.5	0	0	Rocky Cape
3	4	9-Jun-93	0	0	0.5	0	0.5	0	0	8	39.3	0	0	0.3	50	0.3	2.3	0	0	Rocky Cape
3	4	30-Oct-95	0	0	0	0	0	0	0	0	12	0.8	0	0	0	0	0.5	0	0	Rocky Cape
4	1	23-Apr-92	0	0	0	0	0	0	0	0.3	0	0	0	0	0	15	5.3	0	1.5	West Waterhouse I.
4	1	23-Oct-95	0	0	0	0	0	0	0	0	0	0	0	0	0	4.3	5	0	0.5	West Waterhouse I.
4	2	24-Apr-92	0.5	0	0	0	0	0.3	0	0.8	0	0	0	0	0	1.5	0.5	0	0	Little Waterhouse I.
4	2	23-Oct-95	0	0	0	0	0	0	0	0	0	0	0	0	0	0.3	0	0	0	Little Waterhouse I.
4	3	25-Apr-92	0.3	0	0	0	0	0	0.5	0.5	0	0	0	0	20	0	4	0	1.3	North Croppies Pt
4	3	24-Oct-95	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0.3	0	0.5	North Croppies Pt
4	5	24-Apr-92	0	0	0	0	0	0	0	0	0	0	0	0.3	0.3	3	2.5	2.5	3.3	Waterhouse Pt
4	5	24-Oct-95	0	0	0	0	0	0	0	0	0	0	0	0	0	4.3	3.5	0	0	Waterhouse Pt
4	6	23-Apr-92	0	0	0	0	0	0	0	7	0	0	0	0	0	2.3	0.8	1	2.8	Nth Waterhouse I.
4	6	23-Oct-95	0	0	0	0	0	0.5	0	0	0	0	0	0	0	0.5	2.5	0	0.5	Nth Waterhouse I.

		Species	*Heterodontus portusjacksoni*				*Scorpaena ergastulorum*						*Apogon conspersus*					*Scorpis lineolatus*		
				Cephaloscyllium laticeps				*Gnathanacanthus goetzii*					*Upeneichthys vlaminghii*					*Enoplosus armatus*		
					Urolophus cruciatus				*Caesioperca rasor*					*Pempheris multiradiatus*						
						Conger verreauxi				*Trachinops caudimaculatus*				*Melambaphes zebra*						
							Pseudophycis bachus				*Dinolestes lewini*				*Scorpis aequipinnis*					
		Code	1	3	4	6	9	21	23	25	27	28	29	34	35	39	40	41	43	

Area	Site	Date	Fish species code																	Location
			44	47	48	49	50	51	53	56	57	58	59	60	61	63	64	65	66	
1	1	9-Aug-95	0	0.3	0	1.5	0	0	0	0	0.5	0	0.5	5.25	0	0	0.3	0	0	Impact site
1	1	22-Oct-95	0.3	0.5	0	0.5	0	0	0	0	0.3	0	0.8	5.25	0	0	0	0	0	Impact site
1	2	8-Aug-95	0	0	0	0	0	0	0	0.3	0.8	2	0	7	0	0.5	0	0	0	Northwest Hebe Rf
1	3	9-Aug-95	0	0	0	1	0	0	0	1	0.5	1.8	0	10.5	0	2.8	1	0	0	Northeast Hebe Rf
2	1	11-Apr-94	0	1.3	0	2	0	0	0	1	3	1	0	20.5	0.3	0.5	0	0	0	Low Head
2	1	19-Jul-95	0	0	0	0.3	0	0	0	0.3	0	0	0	5.5	0	0.8	0.3	0	0	Low Head
2	1	4-Oct-95	0	0.3	0	0.3	0	0	0	0.3	3.5	0	0	13.5	0.3	0	0	0	0	Low Head
2	2	12-Apr-94	0	0	0	0	0	0	0	1.3	0.8	0	0	10.25	0	0.3	0	0	0	West Head
2	2	21-Jul-95	0	0	0	0	0	0	0	0	0.3	0	0	2	0	0	0.5	0	0	West Head
2	2	22-Oct-95	0	0	0	0.3	0	0	0	0.3	0	1.3	0	5.5	0	0	0	0	0	West Head
2	8	19-Oct-94	0	1.3	0.3	1	0	0	2	3.7	4.8	7.3	0	20.25	0.3	2.5	14	0	0.3	Barrel Rock
2	8	22-Jul-95	0	0.5	0	0	0	0	1.3	0	0.5	1	0	4	0	0.5	1.8	0	0	Barrel Rock
2	8	22-Oct-95	0	0.5	0	0.8	0	0.3	2.3	2	1.8	4.8	0	11	0.5	3.8	4.5	0	0	Barrel Rock
2	3	12-Apr-94	0.3	0.3	0	2.5	0	0	0	2	4	0	0	15.5	0	0	1	0	0.3	Badger Head
2	3	21-Jul-95	0	0.3	0	0	0	0	0	0.3	0.8	1.5	0	11.75	0	0.5	0.8	0	0	Badger Head
2	3	21-Oct-95	0	0.8	0	1	0	0	0	0	0.8	1	0	6.75	0	0.3	0.3	0	0	Badger Head
2	4	13-Apr-94	0	2	0	3.8	0	0	0	0.8	3.8	0.3	0	17.75	0.3	0.3	5.5	0	1	Stony Head
2	4	22-Jul-95	0	0	0	0	0	0	0	0	0	0.3	0	1.75	0	0	0.3	0	0	Stony Head
2	4	20-Oct-95	0	0	0	1.3	0	0	0	0.5	1.5	0.8	0	9.75	0.5	0	0.5	0	0	Stony Head
2	5	14-Apr-94	0	0.3	0	0.8	0	0	0	0.8	2	0.3	0.3	21.75	0	0	2.8	0	0	Horseshoe Reef
2	5	20-Jul-95	0	0	0	0	0	0	0	0	0.3	1	0	10.25	0	0	0	0	0	Horseshoe Reef
2	5	20-Oct-95	0	0	0	0.3	0	0	0	0.8	0	1	0	8.75	0	0	0	0	0	Horseshoe Reef
2	6	14-Apr-94	0	0	0	1.8	0	0	0	0.8	1	0.3	0	6.25	0.3	1.3	4.8	0	0	Don Heads
2	6	20-Oct-95	0	0	0	0.3	0	0	0	0.5	0	0.5	0	2.5	0	0	0	0	0	Don Heads
2	7	13-Apr-94	0	0.3	0	3	0	0	0	0	1	0.3	0	12.33	0	1.7	6	0	1	Five Mile Bluff
2	7	4-Oct-95	0	0	0	0	0	0	1	0	0.8	0	0	12.25	0	0.3	0.8	0	0.3	Five Mile Bluff
3	1	23-May-92	0.3	0.5	0	2.8	0	0	0	0	1	0.5	4.5	42.5	0	0.3	0.5	0	0	Anniversary Pt
3	1	9-Jun-93	0	0.5	0	0.5	0	0	0	0	0.5	2.3	0.3	28	0.3	0.3	1	0	0.3	Anniversary Pt
3	1	29-Oct-95	0	0	0	0.5	0	0	0	0	0.5	4.3	0.3	20.5	0	1	1	0	0	Anniversary Pt
3	2	23-May-92	0	1	0	2.3	0	0	0	0	2	0.3	1.8	17.25	0	0.8	7.8	0	0.3	Sisters Rocks
3	2	9-Jun-93	0	0.3	0	1.3	0	0	0	0.3	2.5	0.3	0	26.25	0.3	1.8	19	0	0.5	Sisters Rocks
3	2	30-Oct-95	0	0.8	0	0.3	0	0	0	1	0.8	6	1	17.25	0.3	0.3	6.8	0	1.5	Sisters Rocks
3	3	24-May-92	0	0.3	0	4.3	0	0	0	0	2.3	0.5	0	15.75	0	0.5	1	0	0	Boat Harbour
3	3	30-Oct-95	0	0.5	0	0.8	0	0	1	0	0.8	0.8	0	14	0.3	0.3	0	0	0	Boat Harbour
3	4	25-May-92	0.3	0	0	1.3	0	0	0	1	0.8	3.8	2.8	22.75	0.3	0	10	0	1	Rocky Cape
3	4	9-Jun-93	0	0	0	3	0	0	0	0	1.5	4.5	1	15.75	0.3	2.5	47	0	3	Rocky Cape
3	4	30-Oct-95	0	0	0	0.5	0	0	0	0.3	0.3	16	0	6.25	1	2	0.3	0.3	3	Rocky Cape
4	1	23-Apr-92	0	3.8	0.8	6.8	0.25	0	0.3	0.5	1.8	0	0	82.5	0.3	0	2.5	0	1.5	West Waterhouse I.
4	1	23-Oct-95	0	1	0.3	2	0.25	0	0.5	0	0.5	2.8	0	35.25	0.3	0	0	0	0.8	West Waterhouse I.
4	2	24-Apr-92	0	1	0	1.8	0	0	0	0.5	4	1.5	0	29	1.8	9	13	0	2.5	Little Waterhouse I.
4	2	23-Oct-95	0	0.3	0.3	1.8	0	0	0	0.3	0.8	0.3	0	21.75	0	3.3	0.5	0	0	Little Waterhouse I.
4	3	25-Apr-92	0	2.3	0	3.8	0	0	0	0	2.5	0	0	28.25	0	0	6.8	0	1	North Croppies Pt
4	3	24-Oct-95	0	0.8	0.3	2	0	0	0	0	4.3	0.5	0	25.25	0	0	0.3	0	1.8	North Croppies Pt
4	5	24-Apr-92	0.3	2.5	0.3	4.5	0	0	0	4	8.5	0	0	54.25	1	0.5	21	0	0.8	Waterhouse Pt
4	5	24-Oct-95	0.3	2.5	0.3	3	0.25	0.3	0	3.5	5.8	1.8	0	28.25	1	0.8	17	0	0.3	Waterhouse Pt
4	6	23-Apr-92	0	0.8	0.5	4.8	1	0	0	0.3	1.8	0	0	41.75	1	0	15	0	5.3	Nth Waterhouse I.
4	6	23-Oct-95	0	0.3	0.3	1.8	0	0	0	0.3	1.5	4.8	0	24.5	0.5	0.3	2	0	1.3	Nth Waterhouse I.

Species																			
			Cheilodactylus nigripes					*Pictilabrus laticlavius*						*Neoodax balteatus*					
						Cheilodactylus spectabilis				*Notalabrus fucicola*					*Siphonognathus beddomei*				
			Pentaceropsis recurvirostris			*Dactylophora nigricans*				*Pseudolabrus psittaculus*				*Haletta semifasciata*					
				Parma victoriae				*Latridopsis forsteri*				*Notalabrus tetricus*				*Odax cyanomelas*			
					Dactylosargus arctidens				*Dotalabrus aurantiacus*				*Odax acroptilus*						
		Code	44	47	48	49	50	51	53	56	57	58	59	60	61	63	64	65	66	

Area	Site	Date	Fish species code																
			68	70	72	73	74	77	85	87	88	89	90	91	93	95	98	101	103
1	1	9-Aug-95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	1	22-Oct-95	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
1	2	8-Aug-95	0	0.3	0	0	0	0	0	0	0	0	0	0	0.3	0	0	0	0
1	3	9-Aug-95	0	0	0.3	0	0	0	0	0	0	0.25	0	0	0	0	0.5	0	0
2	1	11-Apr-94	0	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	1	19-Jul-95	0	0	0.3	0	0	0	0	0	0	0	0	0	9	0	0.8	0	0
2	1	4-Oct-95	0	0	0	0	0	0	0	0	0	0	0.25	0.8	0.8	0	0.8	0	0
2	2	12-Apr-94	0	0.3	0	0	0	0	0	0	0	0	0	0	0	0	0.3	0	0
2	2	21-Jul-95	0	0.5	0	0.3	0	0	0	0	0	0	0	0	0.3	0	0	0	0
2	2	22-Oct-95	0	0	0	0.3	0	0	0	0	0	0	0	0	0	0	0.3	0.3	0
2	8	19-Oct-94	0	0	0.3	0	0	0	0	0	0	0	0	0.3	1	0	0	0	0
2	8	22-Jul-95	0	0	0	0	0	0	1.25	0	0	0	0	0	0.5	0	0.3	0	0
2	8	22-Oct-95	0	0	0	0	0	0	0	0	0.25	0	0.25	0	1	0	0.3	0	0
2	3	12-Apr-94	0.5	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0.3	0
2	3	21-Jul-95	0.5	0.3	0	0.3	0	0.3	0	0	0	0.25	0.5	0	0.3	0	0.3	0	0
2	3	21-Oct-95	0	0	0	0	0	0	0	0	0	0	0	0.3	0.5	0	0	0	0
2	4	13-Apr-94	0	0	0	0	0	0	0	0	0.5	2	0.25	5.3	0.3	0	0	0	0
2	4	22-Jul-95	0	0	0.3	0	0	0	0	0	0	0	0	0	0	0.3	0	0	0
2	4	20-Oct-95	0	0	0	0	0	0	0	0	0	0	0	0.8	0	0	0.3	0	0
2	5	14-Apr-94	0.3	0.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	5	20-Jul-95	0	0.5	0	0.5	0	0	0	0	0	0	0	0	0	0	0.3	0	0
2	5	20-Oct-95	0.3	0	0	0	0	0	0	0	0	0	0.25	0	0	0	0	0	0
2	6	14-Apr-94	0.5	0	0	0	0.3	0	0	0	0	0	0	0	0	0	0	0	0
2	6	20-Oct-95	0.3	0.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	7	13-Apr-94	0	0	0	0	0	0	0	0	0	1.67	0	0	0.7	0	0	0	0
2	7	4-Oct-95	0	0	0	0.3	0	0	0	0	0.5	0	0	0.3	0.3	0	0	0	0
3	1	23-May-92	0	0	0	0	0	0	0	0	0.75	0.5	0.5	0.3	0	0	0.5	0	0
3	1	9-Jun-93	0	0	0	0	0	0	0	0	0.25	0	0.5	0	0	0	0.8	0	0
3	1	29-Oct-95	0	0	0	0.3	0	0	0	0	0.75	0	0	0	0	0	1.3	0	0
3	2	23-May-92	0.3	0	0	0.5	0	0	0	0	0.75	0	0	0	1.5	0	0.3	0	0
3	2	9-Jun-93	0	0.3	0	0	0	0	0	0	0	0	0	0	10	0	0.3	0	0
3	2	30-Oct-95	0	0	0	0	0	0	0	0	0.25	0	0.5	0	11	0	0	0	0
3	3	24-May-92	0.3	0	0	0	0	0	0	0.25	0.75	0	0.25	0	0.5	0	0.5	0	0
3	3	30-Oct-95	0.3	0	0	0	0	0	0	0	0.25	0	0.25	0	1	0	0.5	0	0
3	4	25-May-92	0	0	0	0	0	0	0	0	2	0	0.25	0.3	1.5	0	0	0	0
3	4	9-Jun-93	0	0	0	0.5	0	0	0	0.25	0.75	0.25	0.25	1.5	8.3	0	0	0	0
3	4	30-Oct-95	0	0	0	0	0	0	0	0	0.75	0	0	0.5	0.8	0	0.3	0	0
4	1	23-Apr-92	0	0	0	0.3	0	0	0	0	1.5	0.75	0	5.3	6.8	0	0	0	0
4	1	23-Oct-95	0.3	0	0	0.3	0	0	0	0	0	0.75	0	2.3	0	0	0.3	0	0
4	2	24-Apr-92	0	0	0	0.3	0	0	0	0	0.5	0.25	0	6	7.3	0	0	0	0
4	2	23-Oct-95	0	0	0	0.3	0	0	0	0	0.75	0.5	0	0.5	0	0	0.3	0	0
4	3	25-Apr-92	0	0	0	1	0	0	0.5	0	0	0.25	0	2.3	0.8	0	0.5	0	0
4	3	24-Oct-95	0	0	0	0	0	0	0	0	0	0	0	1.5	0	0	0.8	0	0
4	5	24-Apr-92	0	0	0	0	0	0	2.5	0	1.25	0	0	2.8	2.3	0	0	0	0
4	5	24-Oct-95	0	0	0	0	0	0	0	0	0.25	0	0.5	4	2.3	0	0	0	0
4	6	23-Apr-92	0	0	0	0	0	0	0	0.25	0	0	0	1.3	3.8	0	0	0	0
4	6	23-Oct-95	0	0	0	0	0	0	0	0.75	0	0	0	1.3	0	0	0	0	0.3

		Species		*Norfolkia striaticeps*					*Acanthaluteres spilomelanurus*				*Meuschenia hippocrepis*						*Hete*
					Heteroclinus forsteri					*Eubalichthys gunnii*				*Penicipelta vittiger*					
						Heteroclinus johnstoni					*Meuschenia australis*				*Aracana aurita*				
							Heteroclinus perspicillatus					*Meuschenia flavolineata*				*Diodon nichthem*			
			Bovichthys variegatus					*Nesogobius sp.*					*Meuschenia freycineti*					*Aetapcus n*	
		Code	68	70	72	73	74	77	85	87	88	89	90	91	93	95	98	101	103

Location	Area	Site	Date	Fish species code											Location
				106	107	108	109	110	113	121	126	127	128	199	
Impact site	1	1	9-Aug-95	0	0	0	0	0	0	0	0	0	0	0	Impact site
Impact site	1	1	22-Oct-95	0	0	0	0	0	0	0	0	0	0	0	Impact site
Northwest Hebe Rf	1	2	8-Aug-95	0	0	0	0	0	0	0	0	0	0	0	Northwest Hebe Rf
Northeast Hebe Rf	1	3	9-Aug-95	0	0	0	0	0	0	0	0	0	0	0	Northeast Hebe Rf
Low Head	2	1	11-Apr-94	0	0	0	0	0	0	0	0	0	0	0	Low Head
Low Head	2	1	19-Jul-95	0	0	0	0	0	0	0	0	0	0	0	Low Head
Low Head	2	1	4-Oct-95	0	0	0	0	0	0	0	0	0	0	0	Low Head
West Head	2	2	12-Apr-94	0	0	0	0	0	0	0	0	0	0	0	West Head
West Head	2	2	21-Jul-95	0	0	0	0	0	0	0	0	1.3	0.3	0.3	West Head
West Head	2	2	22-Oct-95	0	0	0	0	0	0	0	0	0	0	0	West Head
Barrel Rock	2	8	19-Oct-94	0	0	0	0	0	0	0	0	0	0	0	Barrel Rock
Barrel Rock	2	8	22-Jul-95	0	0	0	0	0	0	38	0	0	0	0	Barrel Rock
Barrel Rock	2	8	22-Oct-95	0	0	0	0	0	0	0	0	0	0	0	Barrel Rock
Badger Head	2	3	12-Apr-94	0	0	0	0	0	0	0	0	0	0	0	Badger Head
Badger Head	2	3	21-Jul-95	0	0	0	0	0	0	0	0	0	0	0	Badger Head
Badger Head	2	3	21-Oct-95	0	0	0	0	0	0.3	0	0	0	0	0	Badger Head
Stony Head	2	4	13-Apr-94	0	0	0	0	0	0	0	0	0	0	0	Stony Head
Stony Head	2	4	22-Jul-95	0	0	0	0	0	0	0	0	0	0	0	Stony Head
Stony Head	2	4	20-Oct-95	0	0	0	0	0	0	0	0	0	0	0	Stony Head
Horseshoe Reef	2	5	14-Apr-94	0	0	0	0	0	0	0	0	0	0	0	Horseshoe Reef
Horseshoe Reef	2	5	20-Jul-95	0	0	0	0	0	0	0	0	0	0	0	Horseshoe Reef
Horseshoe Reef	2	5	20-Oct-95	0	0	0	0	0	0	0	0.3	0	0	0	Horseshoe Reef
Don Heads	2	6	14-Apr-94	0	0	0	0	0	0	0	0	0	0	0	Don Heads
Don Heads	2	6	20-Oct-95	0	0	0	0	0	0	0	0	0	0	0	Don Heads
Five Mile Bluff	2	7	13-Apr-94	0	0	0	0	0	0	0	0	0	0	0	Five Mile Bluff
Five Mile Bluff	2	7	4-Oct-95	0	0	0	0	0	0	0	0	0	0	0	Five Mile Bluff
Anniversary Pt	3	1	23-May-92	0	0.3	0.3	0	0	0	0	0	0	0	0	Anniversary Pt
Anniversary Pt	3	1	9-Jun-93	0	0	0	0	0	0	0	0	0	0	0	Anniversary Pt
Anniversary Pt	3	1	29-Oct-95	0	0	0	0	0	0.3	0	0	0	0	0	Anniversary Pt
Sisters Rocks	3	2	23-May-92	0	0	0	0	0.3	0	0	0	0	0	0	Sisters Rocks
Sisters Rocks	3	2	9-Jun-93	0	0	0	0	0	0	0	0	0	0	0	Sisters Rocks
Sisters Rocks	3	2	30-Oct-95	0	0	0	0	0	0	0	0	0	0	0	Sisters Rocks
Boat Harbour	3	3	24-May-92	0	0	0	0	0	0	0	0	0	0	0	Boat Harbour
Boat Harbour	3	3	30-Oct-95	0	0	0	0	0	0	0	0	0	0	0	Boat Harbour
Rocky Cape	3	4	25-May-92	0.5	0	0	0.3	0	0	0	0	0	0	0	Rocky Cape
Rocky Cape	3	4	9-Jun-93	0	0	0	0	0	0	0	0	0	0	0	Rocky Cape
Rocky Cape	3	4	30-Oct-95	0	0	0	0	0	0	0	0	0	0	0	Rocky Cape
West Waterhouse I.	4	1	23-Apr-92	0	0	0	0	0	0	0	0	0	0	0	West Waterhouse I.
West Waterhouse I.	4	1	23-Oct-95	0	0	0	0	0	0	0	0	0	0	0	West Waterhouse I.
Little Waterhouse I.	4	2	24-Apr-92	0	0	0	0	0	0	0	0	0	0	0	Little Waterhouse I.
Little Waterhouse I.	4	2	23-Oct-95	0	0	0	0	0	0	0	0	0	0	0	Little Waterhouse I.
North Croppies Pt	4	3	25-Apr-92	0	0	0	0	0	0	0	0	0	0	0	North Croppies Pt
North Croppies Pt	4	3	24-Oct-95	0	0	0	0	0	0	0	0	0	0	0	North Croppies Pt
Waterhouse Pt	4	5	24-Apr-92	0	0	0	0	0	0	0	0	0	0	0	Waterhouse Pt
Waterhouse Pt	4	5	24-Oct-95	0	0	0	0	0	0	0	0	0	0	0	Waterhouse Pt
Nth Waterhouse I.	4	6	23-Apr-92	0	0	0	0	0	0	0	0	0	0	0	Nth Waterhouse I.
Nth Waterhouse I.	4	6	23-Oct-95	0	0	0	0	0	0	0	0.3	0	0	0	Nth Waterhouse I.

oclinus wilsoni			Species					*Hypoplectrodes nigrorubrum*				*Stigmatopora nigra*			
				Trianectes bucephalus					*Siphonognathus tanyourus*			Unidentified fishes			
					Dasyatis brevicaudatus					*Engraulis australis*					
erus						*Urolophus paucimaculatus*					*Scobinichthys granulatus*				
naculatus							*Raja whitleyi*					*Lovettia sealii*			
			Code	106	107	108	109	110	113	121	126	127	128	199	

Area	Site	Date	Algal species code																Location
			300	301	302	303	304	305	308	309	310	311	312	314	316	318	319	320	322	
1	1	9-Aug-95	1.5	0	2.5	0	0	0	0	0	0	0	0	0	0	1.2	0	0	4	Impact site
1	1	22-Oct-95	8.2	0	0.5	0	0	0.1	0	0	0	0	0	0	0	0	0	0.1	0.2	Impact site
1	2	8-Aug-95	58	0	19	0	0	0	0	0	11	0	0	1.2	0	0	0	0	0	Northwest Hebe Rf
1	3	9-Aug-95	68	0	22	0	0	0	0	0.4	7	0	0	3.7	0	0.9	0	0	0.2	Northeast Hebe Rf
2	1	11-Apr-94	42	0	2.4	0	11	0	0	0	0.6	0	16	11	0	0	0.2	0	0.5	Low Head
2	1	19-Jul-95	20	0	2	9	0	0	9.2	0	0.6	0	0	5.9	0	0	0	0	0.1	Low Head
2	1	4-Oct-95	16	0	0.2	13	0	0	3.8	0	7.6	0	0	12	0	0	0	0	0.3	Low Head
2	2	12-Apr-94	61	0	7.9	0	0	0	0	0	3.2	0	0	0.7	0	0	0	0	2.5	West Head
2	2	21-Jul-95	46	0	9	0	0	0	0	0	3.3	0	0	0.7	0	0	0	0	0	West Head
2	2	22-Oct-95	60	0	8.2	0	1.8	0	0	0	6.3	0	0	1.8	0.5	0	0	0	0	West Head
2	8	19-Oct-94	0	0	1.9	0	0	0	0	2.4	0	0	0	8.6	0	0	0	0	45	Barrel Rock
2	8	22-Jul-95	2	0	4.2	0.3	0	0	0	0	7.1	0	0	13	0	0	0	0	46	Barrel Rock
2	8	22-Oct-95	0.6	0	2.3	0	0	0	0	0	7.4	0.1	0	5.8	0	0	0	0	35	Barrel Rock
2	3	12-Apr-94	57	0	4.3	0	0.6	0	0	0	11	0	7.1	6.6	0	0	0	0	1	Badger Head
2	3	21-Jul-95	39	0	1.7	0.5	0	0	0	2.1	2.1	0	0	4.7	0	0	0	0	0.4	Badger Head
2	3	21-Oct-95	61	0	6.2	0	0	0	0	0	0.4	0	0	5.6	0	0	0	0	4.8	Badger Head
2	4	13-Apr-94	53	0	0	0	0.9	0	0	0	16	0	7	13	0	0	0	0	0	Stony Head
2	4	22-Jul-95	52	0	0	0	0.2	0	1.5	0.8	8.1	0	0	16	6.9	0	0	0	0	Stony Head
2	4	20-Oct-95	32	0	1.7	0	0	0	5.3	0	1.7	0	0	15	0	0	0	0	0	Stony Head
2	5	14-Apr-94	36	0	0	0	0	0	0	0	0	0	0	0.2	0	0	0	0	7.6	Horseshoe Reef
2	5	20-Jul-95	19	0	0	0	0	0	0	0	0	0	0	0.2	0	0	0	0	6.9	Horseshoe Reef
2	5	20-Oct-95	37	0	0	0	0	0	1	0	2.7	0	0	1.8	0	0	0	0	17	Horseshoe Reef
2	6	14-Apr-94	29	0	0	0	0	0	0	0	0.6	0	0	4.5	0	0	0	0	25	Don Heads
2	6	20-Oct-95	19	0	0	0	0.5	0	0	0	0	0	0	5.7	0	0	0	0	3.8	Don Heads
2	7	13-Apr-94	69	0	3.7	0	0	0	0	0	11	0	0	5.1	3.7	0.6	0	0	0	Five Mile Bluff
2	7	4-Oct-95	46	0	3.6	0	0	0	0	0	5.6	0	0	24	3.3	0.5	0	0	0	Five Mile Bluff
3	1	23-May-92	19	0	0.2	0	0	0	0	0	0	0	0	4.7	0	0	0	0	0.5	Anniversary Pt
3	1	9-Jun-93	43	0	0.2	0.8	0	0	0	0	3.6	0	0	1.9	0	0	0.2	0	0.2	Anniversary Pt
3	1	29-Oct-95	45	0	1.2	0	2.2	0	0	0	0	0	0	3.6	0	0	0	0	4.5	Anniversary Pt
3	2	23-May-92	37	0	0.8	0	0	0	0	0	4.2	4.4	0	1.8	0.2	0	0	0	16	Sisters Rocks
3	2	9-Jun-93	49	0	0.5	0	0	0	0	0	2.1	0.7	0	0.5	0	0	0	0	4.3	Sisters Rocks
3	2	30-Oct-95	32	0	2.6	0	0	0	0	0	1.4	0	0	2.4	0	0.7	0	0	18	Sisters Rocks
3	3	24-May-92	40	0	0.5	0.2	0	0	0	0	10	0.1	0	5.6	1.9	0	0	0	4.8	Boat Harbour
3	3	30-Oct-95	31	0	3.9	0	0.5	0	0	0	4.4	0	0	14	0.5	0	0.2	0	7.9	Boat Harbour
3	4	25-May-92	7.1	0	8	0	0	0	0	0.4	1.3	0.8	0	20	0	0	0	0	30	Rocky Cape
3	4	9-Jun-93	14	0	4.7	0.2	0	0	0	1.1	1.7	2.5	0	3.3	0	0	0	0	27	Rocky Cape
3	4	30-Oct-95	15	0	6.1	0	0	0	0	6.6	4.3	0	0	3.7	0	1.5	0	0	26	Rocky Cape
4	1	23-Apr-92	46	0	0.2	0	1.7	0	0	2.9	4.6	0	0	0	2.5	0	0	0.4	0.2	West Waterhouse I.
4	1	23-Oct-95	43	0	0.3	0	0.8	0	0	0	8.6	0	0	0.7	1.4	0	0	0	0.5	West Waterhouse I.
4	2	24-Apr-92	80	0	3.7	0	0	0	2.8	0	6.6	0	0	0	0	0	0	0	0.1	Little Waterhouse I.
4	2	23-Oct-95	1.2	0	0	0	9.6	0	3.2	0	2.8	0	0	13	0	0	0.1	0.1	0	Little Waterhouse I.
4	3	25-Apr-92	57	0	1.1	0	0	0	0	1.4	20	0	0	1.9	3.6	0	0	0	0	North Croppies Pt
4	3	24-Oct-95	37	0	0.1	0	9.3	0	0	0	19	0	0	0	5.2	0	0	0	0	North Croppies Pt
4	4	24-Oct-95	3.9	0.1	0	0	8.4	0	1.1	0	8.3	0	0	5.2	1.7	0	0	0	0.2	Waterhouse Pt
4	5	23-Oct-95	46	0	0.7	0	0	0	0	0	16	0	0	2.4	0.4	0	0	0	0.5	Nth Waterhouse I.

		Species	*Acrocarpia paniculata*					*Colpomenia sinuosa*				*Cystophora polycistidea*				*Dictyota dichotoma*			
				Bellotia eriophorum					*Cystophora expansa*				*Cystophora retroflexa*				*Ecklonia radiata*		
					Carpoglossum confluens					*Cystophora monilifera*				*Cystophora subfarcinata*					
						Caulocystis cephalornithos					*Cystophora moniliformis*				*Cystophora xiphocarpa*				
							Caulocustis uvifera					*Cystophora platylobium*				*Dictyopteris muelleri*			
		Code	300	301	302	303	304	305	308	309	310	311	312	314	316	318	319	320	322	

Area	Site	Date	Algal species code																	Location
			323	324	329	330	332	333	334	335	336	337	338	339	340	343	344	346	347	
1	1	9-Aug-95	0	0	0	0	0	0	0.1	0	0.3	0	2.2	0	0	1	0	0	0	Impact site
1	1	22-Oct-95	55	0	0	0	0	0	0	0	0	0	0	0.4	0	0.6	0	0	0	Impact site
1	2	8-Aug-95	0	2.3	1.2	0	0	6.3	2.3	0	0	0	6.4	0	0	0.7	0.3	0	0	Northwest Hebe Rf
1	3	9-Aug-95	0	2	0	0	1.7	0.4	2	0	6.1	0	0.5	0	0	4	0.4	0	0	Northeast Hebe Rf
2	1	11-Apr-94	0	2.5	0.2	0	0	0	0	1.3	0	0	0	0	2.7	9.5	0	0	0	Low Head
2	1	19-Jul-95	0	0	0	0	2.3	0	0	0	0.5	0	0.3	0	2.7	14	4.4	0	0	Low Head
2	1	4-Oct-95	0	3	0	0	0	0	0.8	0	0.9	0	0	0	11	11	5.3	0	10	Low Head
2	2	12-Apr-94	0	0.5	0	0	0	0	0	0.6	0	0	3.8	0	3.4	11	0	0	0	West Head
2	2	21-Jul-95	0	1.1	0	0	0	0.1	0	0	0	0	2.4	0	0.4	10	2.8	0	0	West Head
2	2	22-Oct-95	0	0.2	0	0	0	1	1.2	0	0	0	0	0	0	5.7	0	0	0.3	West Head
2	8	19-Oct-94	0	3.9	6.6	0	0	0.1	0	0	0	0	1.4	0	2.3	1.1	18	0	0.1	Barrel Rock
2	8	22-Jul-95	0	3.8	5.3	0	0	4.1	0	0	0	0	6.2	0	0.2	1.3	17	0	0.6	Barrel Rock
2	8	22-Oct-95	0	3.8	0	0	0	4.6	0	0.2	0.7	0	5	0	0	2.8	11	0	0	Barrel Rock
2	3	12-Apr-94	0	4.2	0	0	2.5	0.3	0	3.7	0	0	5.2	0	1.2	13	0	0	0	Badger Head
2	3	21-Jul-95	0	0.6	0	0	0	0	0	0	0	0	1.8	0	0.5	5.8	2.2	0	0	Badger Head
2	3	21-Oct-95	0	4.4	0	0	0.9	5.1	0	0	0	0	16	0	0	4.9	4.8	0	0	Badger Head
2	4	13-Apr-94	0	1.6	0	0	0	0	0	1.7	0	0	11	0	0	3.7	0	0	0	Stony Head
2	4	22-Jul-95	0	1.2	0	0	0	0	2.1	0	0	0	5.9	0	0.3	4.7	0	0	6.3	Stony Head
2	4	20-Oct-95	0	1.4	0	0	0.7	0	0	0	1.4	0	8.6	0	0	8.4	0.3	0	0	Stony Head
2	5	14-Apr-94	0	1	0	0	0.2	0	0	0.6	0	0	1.8	0	8.8	15	0.2	0	0	Horseshoe Reef
2	5	20-Jul-95	0	1.6	0	0	0	0	3.5	0	0	0	0.1	0	0.6	5.3	0.2	0	0	Horseshoe Reef
2	5	20-Oct-95	0	1.8	0.4	0	0.2	0	1.3	0	0	0	0.8	0	4.8	8.6	4.3	0	1.5	Horseshoe Reef
2	6	14-Apr-94	0	8.1	0	0	1.8	0	0	0.3	0	2.1	1.5	0	0	16	0	0	0	Don Heads
2	6	20-Oct-95	0	9.7	0	0	0	0	0	0	0	0	0	0	0	14	6.4	0	10	Don Heads
2	7	13-Apr-94	0	0.8	0	0	0	0	0.6	0	0	0	9	0	0	6.7	0	0	0	Five Mile Bluff
2	7	4-Oct-95	0	1.8	0	0	1.8	0	0.5	0	0	0	5.6	0	0	10	0	0	8.9	Five Mile Bluff
3	1	23-May-92	0	0	0	0	1.9	0	0	0	0	0	0.2	0	0	7.7	1.4	0	3.2	Anniversary Pt
3	1	9-Jun-93	0	1.9	0.4	0	5.8	0	0.1	0	0	0	0	0	0	15	1.1	0.1	5.4	Anniversary Pt
3	1	29-Oct-95	0	4.4	12	0	1.2	0	2.8	0	0	0	0.5	0	0	7.7	0.5	0	0	Anniversary Pt
3	2	23-May-92	0	0.3	0	0	5.9	19	0	0	0	0	0	0	0	7.3	2.8	0	0.6	Sisters Rocks
3	2	9-Jun-93	0	0.7	1.2	0	2.7	20	0	0	0.4	0	0	0	0	4	2	0	0	Sisters Rocks
3	2	30-Oct-95	0	0.7	0	0.2	2.5	24	2.2	0	0	0	0	0	0	5	1.7	0	0.7	Sisters Rocks
3	3	24-May-92	0	0.5	0.4	0	3.9	0	0	0	0.2	0	0	0	0	5.3	0.9	0	6.9	Boat Harbour
3	3	30-Oct-95	0	4.7	3	0	1.9	0	0	0	0.8	0	0	0	0	16	0	0	0	Boat Harbour
3	4	25-May-92	0	0.4	0	0	0.3	1.6	0	0	1.6	0	0	0	0	4.4	1.6	0	16	Rocky Cape
3	4	9-Jun-93	0	0	0	0	2.6	19	0	1.9	0.1	0	0	0	0	0.6	1.4	0	10	Rocky Cape
3	4	30-Oct-95	0	0	2.9	0	5.1	32	1.4	0	0	0	0	4.8	0	5.1	0	0	2.6	Rocky Cape
4	1	23-Apr-92	0	8.1	0	0	3.4	5.6	0	0	0	0	6.1	0	0	2	5.9	0	0	West Waterhouse I.
4	1	23-Oct-95	0	3.2	0	0	0.5	1.5	0	0.1	0	0	12	0	3.6	1.6	5.6	0	0	West Waterhouse I.
4	2	24-Apr-92	0	0.1	0	0	1.2	0	0	0	0	0	30	0	0	1.4	0.3	0	0	Little Waterhouse I.
4	2	23-Oct-95	0	0	0	0	0	0	3.6	0	0	0	0	0	2.5	6.7	20	0	10	Little Waterhouse I.
4	3	25-Apr-92	0	0.1	0	0	1.1	0	0	0	0	0	36	0	0	2.5	1.9	0	0	North Croppies Pt
4	3	24-Oct-95	0	0.1	0	0	0.4	0	0	0.2	0	0	13	0	0.4	6	1.2	0	1.4	North Croppies Pt
4	4	24-Oct-95	0	0	0	0	1.1	0	1.5	0	0	0	3.2	0	0	1.9	3.6	0	11	Waterhouse Pt
4	5	23-Oct-95	0	0.2	0	0	0.5	16	0	0.6	0	0	16	0	0	3.3	4.5	0	0	Waterhouse Pt

		Species				*Macrocystis pyrifera*					*Sargassum verruculosum*				*Zonaria turneriana*					
							Perithalia cordata					*Scaberia agardhii*				*Sargassum spp.*				
			Ectocarpus spp.					*Phyllospora comosa*				*Seirococcus axillaris*					*Colpomenia peregrina*			
				Halopteris spp.					*Sargassum fallax*				*Sporochnus spp.*					*Sargassum decipiens*		
					Macrocystis angustifolia					*Sargassum vestitum*					*Xiphophora chondrophylla*					
		Code	323	324	329	330	332	333	334	335	336	337	338	339	340	343	344	346	347	

Area	Site	Date	Algal species code																	Location
			349	350	351	352	353	354	355	357	362	363	364	365	366	367	368	369	370	
1	1	9-Aug-95	0	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Impact site
1	1	22-Oct-95	0	1.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Impact site
1	2	8-Aug-95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Northwest Hebe Rf
1	3	9-Aug-95	0.3	0	0.2	0	0	0	0	0	0	0	0.3	0	0	0	0	0	0	Northeast Hebe Rf
2	1	11-Apr-94	2.2	5.6	0.3	0	0.4	0.3	0	0.5	0	0	0	0	0	0	0	0	0	Low Head
2	1	19-Jul-95	3.8	7.1	0.3	0.8	0	0	0	0.1	0	0	0	0	0	0	0.1	5.7	0	Low Head
2	1	4-Oct-95	1.3	0.9	0.6	0	6.7	0	0	0	0	0	0.1	0	0	0	0	0	0	Low Head
2	2	12-Apr-94	0	0.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	West Head
2	2	21-Jul-95	0.1	2.6	0.7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	West Head
2	2	22-Oct-95	0	0.4	0.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	West Head
2	8	19-Oct-94	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0	4.2	Barrel Rock
2	8	22-Jul-95	0	1.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.8	Barrel Rock
2	8	22-Oct-95	0.5	3.4	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Barrel Rock
2	3	12-Apr-94	2.2	0.6	1	0	0.2	0	0	0	0	0	0	0	0	0	0	0	0.2	Badger Head
2	3	21-Jul-95	1	6.6	0.4	0	0	0	0	0	0	0	0	0	2	0	0	0	0	Badger Head
2	3	21-Oct-95	1.5	0.7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Badger Head
2	4	13-Apr-94	0.5	7.3	0.2	0	0.2	0	0	0	0	0	0	0	0	0	0	0	0.1	Stony Head
2	4	22-Jul-95	0	5.1	5.2	0	3.5	0	0	0.1	0	0	0	0	0	0	0	0	0	Stony Head
2	4	20-Oct-95	0.3	4.8	0.1	0	0	0	0	0	0	0	0	0	0	0	0	6	0	Stony Head
2	5	14-Apr-94	5.7	1.3	0.8	0	0.3	0.2	0	0	0	1.1	0.1	0	0	0	0	0	0	Horseshoe Reef
2	5	20-Jul-95	7.1	1.9	0	0	0	0	0	0	0	0	0.2	0	0	0	0	0	0	Horseshoe Reef
2	5	20-Oct-95	0.6	7.7	0	0	8.5	0	0	0	0	0	0	0	0	0	0	0	0	Horseshoe Reef
2	6	14-Apr-94	0	6	0	0	0.1	0	0	0.3	0	0	0	0	0	0	0	0	0	Don Heads
2	6	20-Oct-95	9.5	0	0	0	0.7	0	0	0	0	0	0	0	0	0	0	0	0	Don Heads
2	7	13-Apr-94	0	1.1	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0	0	Five Mile Bluff
2	7	4-Oct-95	0.7	1.1	0.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Five Mile Bluff
3	1	23-May-92	2.9	0	0.3	0	1.4	0	0	0	0	0.4	0	0	0	0.1	0	0	0	Anniversary Pt
3	1	9-Jun-93	1.7	1.2	2.3	0	0	0	0.2	0.1	0	0.1	0	0	0	0	0	3.2	0	Anniversary Pt
3	1	29-Oct-95	4.2	7.6	11	0	0	0	0	0.2	0	0	0	0	0	0	0	0.3	0.1	Anniversary Pt
3	2	23-May-92	1.7	0	0	0	0.6	0	0	0	0	0	0	0	0	0	0	0	0.2	Sisters Rocks
3	2	9-Jun-93	0.6	0	2.7	0	0	0	0	0	0	0.8	0	0	0	0	0	1	0	Sisters Rocks
3	2	30-Oct-95	3.8	2.8	0	0	0	0	0	0	0.3	0.4	0	0	0	0	0.2	3.1	0	Sisters Rocks
3	3	24-May-92	0.5	0	0.9	0	0.3	0	0	0	0	0	0	0	0	0	0	0	0	Boat Harbour
3	3	30-Oct-95	6.8	7.2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Boat Harbour
3	4	25-May-92	5.8	0	0.7	0.7	0.3	0	0.3	0	0	0	0	0	0	0	0.1	0	0	Rocky Cape
3	4	9-Jun-93	2.9	0	1.3	0.3	0	0.1	0	0	0	1	0	0	0	0	0	0	0	Rocky Cape
3	4	30-Oct-95	0.8	12	0.8	0	0	0	0.2	0	0	0	0	0	0	0	0	0.7	0	Rocky Cape
4	1	23-Apr-92	8.2	0	4.3	0	0	0	0	0.2	0	0	0	0	0	0	0	2.6	0	West Waterhouse I.
4	1	23-Oct-95	1.5	2.2	9.4	0	0	0	0	0	0	0	0	0	0	0	0	0.2	0	West Waterhouse I.
4	2	24-Apr-92	0.7	3	0	0	0.2	0	0	0	0	0	0	0	0	0	0	0	0.2	Little Waterhouse I.
4	2	23-Oct-95	0	0	3.4	0.1	1.7	0	0	0.1	0	0	0	0	0	0	0	4	0	Little Waterhouse I.
4	3	25-Apr-92	4.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	North Croppies Pt
4	3	24-Oct-95	0.2	0.1	1.3	0	1.6	0	0	0.1	0	0	0	0	0	0	0	0.2	0	North Croppies Pt
4	4	24-Oct-95	0.5	4.3	1.6	0	33	0.3	0	0.1	0	0	0.2	0	0.3	0	0	22	0	Waterhouse Pt
4	5	23-Oct-95	0	2.5	1.1	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0.1	Waterhouse Pt

		Species		*Sargassum sonderi*					*Caulerpa l*		*Codium fragile*					*Dictyosphaeria serica*				
					Caulerpa brownii					*Caulerpa s*		*Codium spp.*					*Caulerpa annulata*			
						Caulerpa cactoides							*Codium pomoides*					*Caulerpa flexilis var. muelleri*		
							Caulerpa flexilis							*Ulva spp.*					*Bailia callitricha*	
			Sargassum varians					*Caulerpa geminata*							*C. obscura*					
		Code	349	350	351	352	353	354	355	357	362	363	364	365	366	367	368	369	370	

Area	Site	Date	Algal species code																		Location
			371	372	373	376	379	380	382	383	384	385	387	389	396	411	414	416	423	438	
1	1	9-Aug-95	0	0	0	0	0	0	0	2.2	0	0	0	0	0	0	0	0	0	0	Impact site
1	1	22-Oct-95	0	0	0	0	0	0	0	0.1	0	0	0.1	0	0	0	0	0	0	0.3	Impact site
1	2	8-Aug-95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Northwest Hebe Rf
1	3	9-Aug-95	0	0	0	0	0	0	0	0	0.8	0	0	0	0	0	0	0	0	0	Northeast Hebe Rf
2	1	11-Apr-94	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Low Head
2	1	19-Jul-95	0	0	0	0	1.6	0	0	0	0	0	0	0	0	0	0	0	0	0	Low Head
2	1	4-Oct-95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Low Head
2	2	12-Apr-94	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0	West Head
2	2	21-Jul-95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	West Head
2	2	22-Oct-95	0	0	0	0	0	0	0	0	0.7	0	0	0	0	0	0	0	0	0	West Head
2	8	19-Oct-94	0.1	0	0	0.6	0.4	0.7	0	0.8	0.5	0	0	0	0	0	0	0	2.7	0	Barrel Rock
2	8	22-Jul-95	0.5	0.3	0	0.7	0.9	0	0	0	1.3	0	0	0	0	0	0	0	2.5	0	Barrel Rock
2	8	22-Oct-95	0	0	0	0	0	0	0	0	0.6	0	0	0	0	0	0	0	1.5	0.1	Barrel Rock
2	3	12-Apr-94	0	0	0	0	0	0	0	0	0.4	0	0	0	0	0	0	0	0	0	Badger Head
2	3	21-Jul-95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Badger Head
2	3	21-Oct-95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Badger Head
2	4	13-Apr-94	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Stony Head
2	4	22-Jul-95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Stony Head
2	4	20-Oct-95	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0	Stony Head
2	5	14-Apr-94	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Horseshoe Reef
2	5	20-Jul-95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	Horseshoe Reef
2	5	20-Oct-95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Horseshoe Reef
2	6	14-Apr-94	0	0	0	0	0	0	0	0	1.7	0	0	0	0	0	0	0.2	0	0	Don Heads
2	6	20-Oct-95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Don Heads
2	7	13-Apr-94	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Five Mile Bluff
2	7	4-Oct-95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Five Mile Bluff
3	1	23-May-92	0	0	0	0	0	0	0	0.4	0	0	0	0	0	0	0	0	0	0	Anniversary Pt
3	1	9-Jun-93	0	0	0.2	0	0	0	0.4	0	0	0	0	0	0	0	0	0.6	0	0	Anniversary Pt
3	1	29-Oct-95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Anniversary Pt
3	2	23-May-92	0	0	0	0	0	0	0.2	0	0.1	0	0	0.3	0	0	0	0	0	0	Sisters Rocks
3	2	9-Jun-93	0	0	0	0	0	0	2.9	0	0	0	0	0	0	0	0	0.3	0	0	Sisters Rocks
3	2	30-Oct-95	0	0	0	0.3	0	0	0.9	0	0	0	0.3	0	0	0	0	0	0	0	Sisters Rocks
3	3	24-May-92	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Boat Harbour
3	3	30-Oct-95	0	0	0	0	0	0	0	0.4	0	0	0	0	0	0	0	0	0	0	Boat Harbour
3	4	25-May-92	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Rocky Cape
3	4	9-Jun-93	0	0	0	0	0	0	0	0	0.5	0.3	0.9	0	0	0	0	0	0	0	Rocky Cape
3	4	30-Oct-95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Rocky Cape
4	1	23-Apr-92	0	0	0	0	0	0	0	1.1	2.6	0	0.3	0	0	0	0	0	0	0	West Waterhouse I.
4	1	23-Oct-95	0	0	0	0	3.6	0	0	0.6	4.2	0.7	4.2	0	0	0	0	0	0	0.9	West Waterhouse I.
4	2	24-Apr-92	0	0	0	0	0	0	0	0.7	0.9	0	0	1	0	0	0	0	0	0	Little Waterhouse I.
4	2	23-Oct-95	0	0	0	0	0	0	0	0	0.4	0	0	0	0	0	0	0	0	0.7	Little Waterhouse I.
4	3	25-Apr-92	0	0	0	0	0	0	0	0.8	1.3	0	0	0	3.2	0	0	0	0	0	North Croppies Pt
4	3	24-Oct-95	0	0.1	0	0	0.3	0	0	0.5	0.9	0.2	1.1	0	0	0	0	0	0	0	North Croppies Pt
4	4	24-Oct-95	0	0	0	0	1.2	0	0	0	0.3	0	0	0	0	0.3	0	0	0	0	Waterhouse Pt
4	5	23-Oct-95	0.1	0	0	0	0	0	0	0.3	0.5	0	0	0	0	0	0	0	0	0.8	Waterhouse Pt

		Species		*Champia viridis*					*Melanthalia obtusata*					*Plocamium*	*Areschougia sp.*					
					Delisea spp.					*Phacellocarpus labillardieri*						*Dictymenia harveyana*				
						Hemineura frondosa					*Plocamium angustum*							*Cladostephus spongiosus*		
							Laurencia spp.					*Plocamium cartilagineum*							*Ballia scoparia*	
			Callophyllis rangiferinus					*Lenormandia marginata*					*Plocamium*	*Pterocladia capillacea*					*Asparagopsis spp.*	
		Code	371	372	373	376	379	380	382	383	384	385	387	389	396	411	414	416	423	438

Area	Site	Date	Algal species code																	Location
			440	410	500	501	503	504	506	509	511	514	527	700	701	702	800	999	402	450	
1	1	9-Aug-95	0	0	0	0	0	0	50	0	0	0	0	0	0	0	0	0	0	0	Impact site
1	1	22-Oct-95	0	0	0	0	0	0	0	0	0	0	0	1.3	0.8	0	2.8	0	0	0	Impact site
1	2	8-Aug-95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Northwest Hebe Rf
1	3	9-Aug-95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Northeast Hebe Rf
2	1	11-Apr-94	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Low Head
2	1	19-Jul-95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Low Head
2	1	4-Oct-95	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	Low Head
2	2	12-Apr-94	0	0	0	0	0	0	1.5	0	0	0	0	0	0	0	0	0	0	0	West Head
2	2	21-Jul-95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	West Head
2	2	22-Oct-95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	West Head
2	8	19-Oct-94	0	1.2	0	0	0	0	0	0	2.6	0	0	0	0	0	0	0	0.9	0	Barrel Rock
2	8	22-Jul-95	0	1.1	0	0	0	0	0	0	0.7	0.4	0	0	0	0	0	9.3	0.9	0	Barrel Rock
2	8	22-Oct-95	0	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	4.5	0.8	0	Barrel Rock
2	3	12-Apr-94	0	0	0	0	0	0	0.4	0	0	0	0	0	0	0	0	0	0	0	Badger Head
2	3	21-Jul-95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Badger Head
2	3	21-Oct-95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Badger Head
2	4	13-Apr-94	0	0	0	1.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Stony Head
2	4	22-Jul-95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Stony Head
2	4	20-Oct-95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.4	0	0	Stony Head
2	5	14-Apr-94	0	0	0	0	0.3	0	0	1.3	0	0	0	0	0	0	0	0.2	0	0	Horseshoe Reef
2	5	20-Jul-95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Horseshoe Reef
2	5	20-Oct-95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Horseshoe Reef
2	6	14-Apr-94	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.3	0.7	0	Don Heads
2	6	20-Oct-95	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Don Heads
2	7	13-Apr-94	0	0	0	0	0	0	3.7	0	0	0	0	0	0	0	0	1.6	0	0	Five Mile Bluff
2	7	4-Oct-95	0	0	0	0	0	0	1.6	0	0	0	0	0	0	0	0	0	0	0	Five Mile Bluff
3	1	23-May-92	0	0	0.3	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	Anniversary Pt
3	1	9-Jun-93	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Anniversary Pt
3	1	29-Oct-95	0	0	0	0	1.3	0	0	0	0	0	0	0	0	0	0	0.8	0	0	Anniversary Pt
3	2	23-May-92	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Sisters Rocks
3	2	9-Jun-93	0	0	0.2	0	0	0.8	0	0	0	0	0	0	0	0	0	0	0	0	Sisters Rocks
3	2	30-Oct-95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.8	0	0	Sisters Rocks
3	3	24-May-92	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Boat Harbour
3	3	30-Oct-95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.9	0	0	Boat Harbour
3	4	25-May-92	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Rocky Cape
3	4	9-Jun-93	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.7	0	0	Rocky Cape
3	4	30-Oct-95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Rocky Cape
4	1	23-Apr-92	0	0	0.4	0	0	0	0	0	0	0	0	0	0	0	0	0.4	0	0	West Waterhouse I.
4	1	23-Oct-95	0	0	0.3	0	0	0	0	0	0	0	0	0	0	0.4	0	0.5	0	0	West Waterhouse I.
4	2	24-Apr-92	0	0	0	1.1	0	0	0	0	0	0	0	0	0	0	0	1.4	0	0	Little Waterhouse I.
4	2	23-Oct-95	0	0	11	0	0	0	0	0	0	0	0.7	0	0	0.1	0	0.7	4	4.5	Little Waterhouse I.
4	3	25-Apr-92	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	North Croppies Pt
4	3	24-Oct-95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	North Croppies Pt
4	4	24-Oct-95	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0	0.5	0	Waterhouse Pt
4	5	23-Oct-95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Waterhouse Pt

		Species	*Botryocystis browni*					*Cystophora congesta*				*Codium harveyi*				Other foliose red algae				
				Euptilota articulata					Filamentous brown algae				*Petalonia fascia*				*Amphibolis antarctica*			
					Sargassum heteromorphum				*Lobophora variegata*					*Scytosiphon lomentaria*				*Posidonia australis*		
						Sargassum lacerifolium				*Gelidium spp.*						*Lobospira tricuspidata*				
							Asperococcus bullosus				*Chaetomorpha sp.*					*?Nitophyllum sp.*				
		Code	440	410	500	501	503	504	506	509	511	514	527	700	701	702	800	999	402	450	